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Vliv green IT v oblasti řízení malých a středních podniků

The Influence of Green IT on the Management of Small and Medium Enterprises

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Prohlašuji, že jsem práci, včetně všech příloh, vypracovala samostatně.

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Abstract

The aim of this dissertation is to examine and evaluate the awareness and the application of Green IT amongst IT managers, network administrators or company directors of small and medium-sized businesses in the United Kingdom and Czech Republic. The paper also discusses strong and weak scopes of Green IT and connects them to factors, such as company's number of employees, its business sector and the country of employment. In order to assess the situation, a research based on an on-line questionnaire has been carried out. Then collected data was analysed and conclusions were drawn. It was found that there are links between the implementation of Green IT options, the number of employees in the company and the business area. The results also showed that the country of employment has no direct impact on the findings and that there are only few cases of relatively different results of the English and the Czech answers.

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1. Introduction

1.1.Introduction to environmentally sustainable computing

Environmentally sustainable computing initiatives or, as it is called in this paper, Green IT is becoming popular for organizations' environmental strategies. According to a survey by IT Governance Research Team (2008), there are several factors that influence companies to implement those initiatives. Factor called 'Saving the planet' is a well-known factor not only for organizations but also for individuals, who are aware of the world's climate change situation. Other factors include legislations and regulations which companies have to comply, improvement of the top line and the bottom line, increasing energy costs, implementation of carbon tax trading scheme, maintaining competitiveness and the last factor is related to the brand image and reputation, which can be improved by following Green IT initiatives.

Other factors could be formed by increasing pressures from customers, employees, business partners or shareholders to adopt green initiatives. Pressures from business partners might be accompanied by environmental audits within the supply chain, therefore the number of companies with implemented environmental management systems, such as ISO 14001 standard, is growing. Organizations under ISO 14001 standard also commit themselves to request their business partners to implement those standards too. (Barry, 1996).

1.2.Aims of study

The aim of this study is described by four research objectives below.

- To examine and evaluate the awareness and the application of Green IT amongst small and medium-sized enterprises;

As organizations continue to adopt programs and practices to drive enterprise-wide responsibility for the environment, IT departments get increasing importance in the broader corporate green initiatives.

- To determine possible strong or weak areas of Green IT;

Efforts to greener approach to information technology are one of the current trends. Manufacturers are trying to offer hardware with low power consumption, good recyclability and minimal environmental pollution by its manufacture. However, there is no directive that orders companies to acquire such equipment.

- To compare those areas of Green IT and find out possible connection with company's business sector;

Green IT is mostly a technical area therefore some companies may not have the necessary staff or knowledge for its implementation.

- To examine differences between SMEs located in the United Kingdom and SMEs located in Czech Republic.

Both countries are members of the European Union however their laws and regulations may be more stringent. Therefore the involvement of companies situated in different countries may vary.

Before the evaluation of the questionnaire these four hypotheses have been assumed:

- 40 % of participating companies never heard about environmental management systems;
- 50 % of participating companies heard about carbon footprint calculation but they do not plan to implement this option;
- There is a link between the implementation of EMS systems and the number of employees in the company;
- 70 % of participating companies provide resources for Green IT activities that do not require high additional costs and they are not time consuming. Those activities include computers power settings, equipment consolidation, storage optimization, interaction with employees, reducing paper consumption, green devices purchase, recycling and disposal under the WEEE Directive.

1.3.Overview of chapters

The rest of this thesis is organized as follows. Literature review covered in the next chapter provides theoretical background which includes information and communications technology and its impacts, environmental management systems, various sections of Green IT and the definition of small and medium-sized enterprises. Methodology is described in the chapter three which outlines the advantages and disadvantages of the research method chosen to examine the issues of Green IT. The data collection is described also in the chapter three together with research objectives, hypotheses and the limitations of the research. Chapter four analyses respondents' profiles and gathered data. The method used for the analysis of hypotheses is introduced and carried out in the chapter five. Chapter six discusses the research objectives considering the research findings which are linked to the literature review. Finally, conclusions are drawn in chapter seven which summarizes the study and its findings together with recommendations for a further research.

2. Mapping the Green IT issues in the context of management of small and medium-sized enterprises

2.1. ICT and its impact

Information and communications technology (ICT) include information technologies used for a communication and work with information. This term has accompanied us for decades. It refers to the telephone and computer networks, including hardware such as computers, servers or other networking devices and software with many operating systems, network protocols or computer programs.

The rapid grow of ICT production resulted in very short life cycles for electronic products such as computers and mobile phones. The World Bank's study (2012) reported that about three quarters of the world's population has a cell phone and 2.5 billion people have an access to the internet. (Miniwatts Marketing Group, 2012). We have been using some kind of a communication technology every day for more than a century now but only four decades ago people realized that IT might have some impact on our environment, both positive and negative.

Mass production, usage and disposal of hardware equipment cause negative impacts on the environment; IT industry has a share of 2 to 2.5 percent on carbon dioxide (CO_2) emissions, the carbon footprint of mobile phones and networks is expected to reach 58% of ICT contribution by 2020. (Blume et al., 2010). About 2 to 6 percent of the energy consumption worldwide is consumed by IT. (Hossain et al., 2012).

Electronic waste (e-waste) is getting attention because it is one of the fastest growing parts of solid waste. Personal computers are made from 1500-2000 components. It has been found that only 2 percent of the material used for their production becomes a part of the product. Other 98 percent goes into the waste stream. (Hilty and Ruddy, 2000). The manufacture and disposal of an electronic equipment cause air, water and soil pollution due to the presence of metals, such as mercury, lead, arsenic or cadmium, and toxic substances. For example, the production of semiconductors produces air and water emissions. (EPA, 1995; UNEP, 2005). Manufacturers producing IT should accept the responsibility for those electronic products and for their safe disposal or recycling and they should design cleaner products. Companies and individuals using IT should prevent their pollution and apply practices such the usage of Green IT.

Sustainable development was best defined by the World Commission on Environment and Development in 1987 in the famous Brundtland Report: "In order to be considered sustainable, a pattern of development has to be able to meet the needs of the present generations without compromising the ability of future generations to meet their own needs." (Brundtland, 1987). ICT causes risks for this sustainable development goal but it also helps to approach the goal. These impacts of ICT on the sustainable development are direct

and even indirect, which are caused by their application in the long term. (Hilty and Ruddy, 2000).

2.2.Defining small and medium-sized enterprises

Small and medium-sized enterprises or small and medium businesses (SMEs) are companies with limits for the number of employees but each country may have its own definitions of what constitutes a SME. SMEs in Denmark have less than 500 employees, Mexican and Brazilian small and medium companies have between 1 and 100 employees, Australian employee fewer than 200 people and in some countries SMEs are defined by their assets. (Hillary, 2000). According to the European Commission (EC) recommendation, there are three groups defining SMEs: micro businesses with up to 10 employees, small businesses with up to 50 employees and medium businesses with up to 250 employees. SMEs are also defined by limitations of either an annual turnover not exceeding 2-50 million EUR and/or an annual balance-sheet total not exceeding 2-43 million EUR. (EC recommendation 2003/361).

2.3.Improving environmental impacts

Small and medium enterprises represent 99% of 23 million companies and provide around 75 million jobs, which constitutes two thirds of the private sector working positions mainly created by micro and small businesses in the European Union and also create most new positions. They outnumber large businesses in most economies. Those companies are important for the economic growth because of their significant share on gross domestic product. (Hillary, 2000).

The pressure to address environmental issues is increasing. Hillary believes that they cause about 70% of worldwide pollution. (Hillary, 1995). Facing environmental awareness and sustainability may be a complex issue for SMEs. Randmer (1999) observes that their key motivations for improving the environmental impacts are expectations of reducing costs or improvements of their image and better communication with other companies or within the business. Lack of time, resources, finance or environmental expertise seems to be the major barriers but organizations should estimate their environmental impacts and set a plan how to reduce them.

2.3.1. Motivation for adopting Green IT

What are company's motivations to adopt a Green IT system? Molla & Abareshi (2011) noted that the reasons, why companies go green, are grouped in two categories. The first, eco-efficiency, is related to a company's desire to sell their goods and services for a competitive price or to reduce their costs while their ecological impact is decreasing and the company is improving the eco-sustainability. The necessity of saving paper copies or storing data demands more power. Energy costs are growing and firms need to reduce them. Cost saving is the main motivator for adopting Green IT.

The second, eco-equity, is focused more on the sustainable development and equality of people. On the other hand, eco-effectiveness tends to preclude contamination and

depletion and encourages companies to direct their attention to environmental problems. SMEs usually have no environmental department or no employee who is responsible for addressing environmental issues as big companies have. It is up to the IT department to consider joining workshops or trainings of an environmental IT strategy in order to stay competitive. A research of a firm's environmental impact could help IT managers to develop standards or procedures for Green IT. (Molla & Abareshi, 2011).

2.4.Green of IT

Many studies about the influence of ICT are focused on the economy or society but with the growing influence of ICT and globalization it was only a matter of time before studies of connection with the environment and sustainable development appeared. The term "Green IT" is used for connection between two areas - environmental issues and information technology (communication technology applies here as well). Green IT can influence people's lifestyle, economics and even a company's style of management.

ICT plays an important role in the context of addressing environmental issues. Two percent of the global carbon emissions are produced by the production and use of ICT and the number is still growing. Green IT could be divided into two main areas – 'Green of IT' and 'Green by IT'.

Activities in the area 'Green of IT' are connected with individual stages of in the life cycle of ICT product and with ICT operation. The operation is usually divided into End User Computing and Enterprise Computing. End users usually work with computers, where the attention is now shifting to portable and mobile devices, which can significantly reduce the energy consumption. Great savings could be realized by managing the operation of printers and other office equipment technology. Companies, as a part of the green initiatives, focus on the building and data centres operation, networks implementation and operation and server consolidation, virtualization and cloud computing. (Buchalcevová et al., 2011).

'Green by IT' has a goal of reducing remaining 98% of global carbon emissions caused by any other elements. In sum, Green IT focuses on carbon emissions, company's energy performance and sustainable growth. (Mlejnek, 2012).

2.4.1. Server consolidation and virtualization

Server consolidation deals with server computers unification and virtualization became its primary tool. Virtualization was developed in the late 1960s and it puts an effort to replace physical computers with computers created with software to make more efficient use of hardware. The area of consolidation and virtualization of servers, then, has a goal of reducing the number of physical server computers, which is necessary for operating the data centre. This can lead not only to the support and maintenance costs reduction, but also to a direct reduction of the energy consumption costs and to an indirect reduction of energy consumption required to cool the servers. Therefore, consolidation and virtualization

increase the use and effectiveness of the remaining servers. Isolation, security and efficiency are the greatest benefits of using virtual machines. (Mlejnek, 2012).

Blowers and Clarke (2003) observed that server consolidation can bring a company many benefits. It can make servers and storage operation sustainable in the long term, utilize servers, it makes them scalable, reduces costs of access, back-up, data protection and it could simplify the infrastructure, which reduces overheads, staff and maintenance costs. Songini (1999) demonstrates that companies could annually reduce their ICT costs by 10 to 15 percent with consolidation programs and simplified server environment, including costs of hardware depreciation, site and staff management. Wray (2012) points out the green advantages of server consolidation. The reduced need for energy-consuming equipment can result in decreased electricity consumption and heat production that was produced by the equipment standing idle most of its lifetime. A survey by Garcia-Guirado et al. (2011) concurs that server consolidation can improve scalability and the static power consumption could decrease by 54 percent.

Vogels (2008) observed that 81 percent of companies use virtualization to drive consolidation and reduce the amount of hardware, ecological footprint of data centre and energy consumption. He also pointed out that server consolidation could reduce the server footprint by 30 to 50 percent or even more and that it could lead to reduced need for staffing, therefore decreased operational costs and capital investment requirements.

Another important area of server consolidation is cloud computing, which is inherently energy-efficient data centre architecture. (Berl et al., 2009). Used together with virtualization, it can greatly reduce energy costs related to the use of software and hardware and it can save greenhouse gasses and CO_2 emissions arising from operating data centres. Cloud computing is not only a technological improvement but it should be perceived as a change of IT use. (Berl et al., 2010).

2.4.2. Data centre optimization

Data centre optimization is focused on improving the functioning conditions of computers, improving rooms or buildings, in which computers are situated. This field is mainly about the optimization of computer operation, which includes the design of air conditioning and replacement of floor tiles, making it possible to obtain about 1 or 2 degrees different temperature, regular cleaning of the data centre, which aims to reduce dust and dirt, preventing proper air flow, and thus reducing the efficiency of the cooling system.

Every small change in the operation of the data centre might help to increase its energy efficiency. Daim et al. (2009) declared that data centres consume 10 to 30 times more energy than normal offices and the amount is doubling every five years. Howard and Holmes (2012) confirm that data centres energy consumption doubled in the period of 2000 to 2005 and the amount constitutes 1 percent of the global electricity use. Moreover, Greenburg et

al. (2006) claim that the energy consumption of data centres is 40 times higher than the consumption of conventional office buildings.

Mlejnek (2012) claims that two-year costs of electricity and cooling servers are currently equal to the purchase price of those servers. According to his study, those costs are still increasing. Bhatia (2012) described several trends in the data centre optimization, managers carefully select locations for data centres in order to reduce the energy costs because the technology allows companies to remotely control their centres. A major role in the selection process play several elements, for example, expenses for a kilowatt hour, labour costs and mainly temperature levels, because lower outside temperatures could save the energy that would be used for cooling the data centre.

Data centre optimization is closely linked to server consolidation and virtualization. There are two international metrics for measuring cost- and energy-effectiveness – power usage effectiveness and carbon usage effectiveness. The knowledge of ICT devices and their efficiency is necessary to design and build an energy-efficient and cost-effective data centre or office. (Bhatia, 2012). Polfliet et al. (2011) similarly observe that professional designs of data centres focused on costs of servers operation and electricity costs could lead to a decrease in the energy consumption by 88 percent. Flucker and Tozer (2013) point out that the improvement of facilities in any age could bring a return of investment in a period shorter than one year.

There are several systems addressing environmental impact of ICT. The Code of Conduct on Data Centres is EC's voluntary system for companies and it helps them to reduce the energy consumption of their data centres and become more energy efficient. The system focuses on the use of the best practices and it is similar to US program Leadership in Energy and Environmental Design (LEED). (EC, 2008). LEED is also a voluntary system but unlike the European system it is more focused on the whole building architecture. Buildings under LEED rating system achieve a certain amount of points to become certified. There are six areas examined by LEED: a choice of location; water usage effectiveness; the energy and atmosphere; materials and resources, the quality of indoor environment and innovative design. (Tugrul et al., 2009). Austria has Energy Agency which identifies the best practices for servers operation and data centres. (Schappi et al., 2007). French program Environment and Energy Management Agency is focused on gathering and sharing information and on providing financial and technical support to reduce the energy consumption. (Howard & Holmes, 2012). One of the most well known programs is Green Grid, founded in 2007. This global program is focused on improving data centres energy efficiency through measuring processes and new technologies to support the performance and growth. Green Grid developed two metrics used for measuring effectiveness and energy consumption - Power Usage Effectiveness and Data Center Infrastructure Efficiency. (Mlejnek, 2012).

2.4.3. Thin clients

Thin clients are devices / computers that provide its users the same user interface, same applications and the same performance as a standard personal computer (PC). The difference between a thin client and a PC is in the power resource. All required power is supplied via a server, which the thin client is connected to. In the case of an extensive computer infrastructure, a significant reduction in the energy consumption can then be achieved by the economies of scale. The following figure (Figure 2.1) shows the size of a thin client compared to a normal-sized monitor. Aside from the energy savings, the figure shows that the thin client is also very economical in terms of the space required on the desk, as opposed to a PC. A thin client weights approximately 60 to 70 percent less than a PC. (Mlejnek, 2012). Some of the latest models of thin clients are able to be mounted to the back of standard LCD monitors to save even more space on the desk.

Figure 2.1 - Thin client (Ingenuity IT, 2011)

In the case of thin clients, the operation is about individual solutions, because even though the thin client is cheaper than a PC and it also consume less power, it requires more communication with the data centre. Therefore, this leads to an increase in its energy intensity. Server-based computing is cheaper if PCs are replaced by thin clients which use 85 percent less power than PCs. Significant savings could be also achieved with integrated liquid crystal displays (LCDs). (Greenburg & Anderson, 2001).

Another advantage of thin clients lies in their life cycle. PCs become usually outdated after only three years long usage due to the innovations and improvements in hardware and software, computing speed and memory capacity. However, a thin client could last twice as long because it has fewer hardware and software components than a PC and therefore it has a smaller chance to get damaged since there are fewer moving hardware components, for

example, a hard disk drive. Other way of saving the environment results from easier and cheaper shipping and handling. Due to its size, more thin clients fit in a package, which lowers the costs of packaging and posting. (Mlejnek, 2012).

2.4.4. Storage Optimization and Data Storage Solutions

Data storage optimization is in particular the reduction of data volume by removing duplication (redundancy) and compression (reduction in volume), shifting infrequently used data to the backup disks, backup virtualization and consolidation of storage equipment, such as devices and media that can store data.

All of the above is within the Green IT primarily focused on reducing the energy intensity of storage equipment because the ICT energy consumption is largely composed of the energy spent on data management and maintenance. (Mlejnek, 2012).

2.4.5. Automated Power Management Systems

One of the more expensive, but on the other hand, more effective Green IT initiative is the use of Automated Power Management Systems (APMS). APMS watch over and correct the energy consumption of information and communication devices. Nowadays there are many programs for running Power Management. Programs that can automatically shut down the computer if it is not in use, and vice versa at night, it could wake the PC up to allow updates and install the required software over the network. In both cases, it could lead to significant savings. (Mlejnek, 2012). It is not strictly necessary to buy new software if a company wants to implement APMS. Substantial savings in the energy consumption could be achieved also by the correct power settings of individual computers via their operating system, such as monitor, disk and computer automatic shut-off if the device stays idle, which can save a significant amount of energy. University of Sheffield conducted a research of the office host's power consumption and the measurement showed that an idle computer consumes 49 to 78 percent of the power that it consumes when it is used. (Cartledge, 2008).

The APMS provide the capability to collect system information precisely and reliably, without wasting the time of valuable maintenance staff which could be effectively utilized elsewhere. Moreover, manual data collection is usually more difficult to analyse and it could have shortages in range comparing to the automatically collected data.

2.4.6. Office equipment consolidation

The goal is to keep the ratio of ICT equipment and employees in the company efficient – this means that employees do not use more equipment than they really need. Offices could very often become crowded with IT equipment over the time. Most of those devices are not used, but all of them consume electricity. Therefore, it is necessary to gain control over the number of laptops, mobile phones, PDAs, tablets or establish a strategy for consolidating these facilities.

The ideal ratio of office equipment, for example printers, scanner, faxes, is ten employees per device. Therefore, if the company does not achieve such a ratio they should try to

replace individual printers, faxes, etc. by multifunction devices. It is also necessary to take the location of these devices into account. Placing the printer into the hallway instead of one office will increase accessibility of the printer; therefore, more employees would be able to use this device. Among other things, managers could see an advantage in this placing, because users may well change their minds about the necessity of printing the document if they have to come into the hall to get it. (Mlejnek, 2012).

It is ideal for personal devices (PCs, laptops, etc.) to achieve the ratio one employee per device. There could be an operating problem for a company if one employee uses a PC and a laptop or even multiple numbers of laptops as well. In this case, the company needs to examine whether the employee really needs both devices. (Mlejnek, 2012).

2.4.7. Employee behaviour

Changes in technical solutions are very useful but it is the behaviour of people, which is the most important area of Green IT. ICT is an integral part of many people's working lives, yet many of them do not know how to use them properly. Thus, if a company's employees learn to follow Green IT initiatives, it could lead to a reduction of costs not only in terms of energy.

In case of idle equipment, each employee should turn their computer off and disconnect their laptop or mobile phone charger from the network. Screensavers are the opposite of their name since they do not save any energy, rather the contrary. Therefore, none of the computers and laptops in the company should have set the screen saver and instead they should automatically turn off if the device is idle, which can be attained by APMS. Company's printers should be default to double-sided printing in black and white. If the printer has an option called "Locked Print", it should be turned on. This function requires the employee to be present at the time of printing, thus it prevents the printing of unwanted or forgotten documents. Each employee should remove unwanted and unneeded files and e-mails from their computers and other devices. (Mlejnek, 2012).

People behaviour could be changed many ways. According to Mlejnek (2012), the most efficient way in the long run in the democratic world is, however, providing enough information, feedback and personal interaction.

Information

People should make informed decisions. It is therefore appropriate to give relevant information to employees and to support this information transfer with managers' personal interaction with employees and with giving them a room for discussion. It is also appropriate to connect different themes and individual events to the overall concept of Green IT, because people can then better understand the problem and its solution and recognize the power of collective work.

Feedback

One of the most important aspects of working with people is providing employees a feedback of the resulting impacts arising from the compliance with green initiatives because

employees see that their actions and deeds have meaning. Potential rewarding and encouraging good conduct can be only profitable.

Personal interaction

Subconscious behaviour is very difficult to change because man usually behaves automatically and does not think about current activity. However, the personal interaction during an interesting conversation can lead to an increased attention and interest to address individual problems. This change of behaviour is certainly much more effective than a direct order from the company management. It is a change from the inside, not a command from the outside.

2.4.8. Green IT purchase

Another important area of Green IT is an area of purchasing new equipment with regard to its suppliers. It is necessary to make an informed decision, to know what impact on the environment the purchase of a certain product will have. It is necessary to take into account not only the energy consumption, but also the extent of toxic substances and heavy metals use in the product. Furthermore, recycling and waste minimization by the supplier should not be forgotten and neither should the efficiency of packing, sending and delivering products. (Mlejnek, 2012).

There are many initiatives that are designed to help companies with decision making when they purchase new equipment:

Electronic Product Environmental Assessment Tool (EPEAT)

EPEAT is a project by The Green Electronics Council organization that helps companies with the purchase of the most green computers, thin clients, workstations and monitors, for example a comparison of products and a selection of electronic devices with the best environmental attributes. (Howard & Holmes, 2012).

Energy Star

Energy Star is an international standard which can be found on many computers, monitors, printers and other consumer electronics. This standard evaluates the energy efficiency of these products. It is a step towards a single system of ICT and consumer electronics evaluation but it still works only on a voluntary basis. New versions of this evaluation system are more stringent than the previous version due to the increasing quality of used technologies. The US version of Energy Star controlled by Environmental Protection Administration (EPA) examines the energy effectiveness of IT devices and it investigates also data centres, its facilities and building efficiency. EPA Energy Star implements its own standards which are now expected to be adopted in the European program for evaluating computer servers. (Howard & Holmes, 2012).

Energy-using products (EUPs)

EUPs system is the European Commission's system which focuses on inefficient technologies and reducing their overall impact on the environment. The system establishes

environmental requirements for energy consuming products. Its aim is to identify and regulate the products' impacts throughout the life cycle of these products, from production through the use to disposal. (Hansen et al., 2005).

2.4.9. Recycling, reusing and equipment disposal

If some ICT equipment is still functional or easily repairable, there is no need to replace it with a new one because the money spent on the replacement could be definitely better utilized, again ideally in Green IT. Even a simple extension of the standard length between the replacements of electrical and electronic equipment in a company could lead to reduction of the environmental impacts. Many ICT manufacturers are now trying to detect their products' carbon output but it is not an easy task because ICT devices usually consist of many components supplied by many manufacturers. A part of the life cycle extension is also repairs. Computer repair and their recovery are very often overlooked as they are considered to be unsatisfactory or too expensive. (Mlejnek, 2012). From the environmental point of view this is not true in most cases. There is no need to throw away or recycle the entire device if only one component is broken.

When office equipment reaches a point where it is no longer meaningfully used, it does not necessarily mean that it cannot be used elsewhere. There are many organizations dealing with the recycling and reuse of unwanted and unused equipment and always in a line with the Waste Electrical and Electronic Equipment (WEEE) directives. The aim of these directives is to reduce the number of produced electrical and electronic equipment and to motivate everyone to re-use, recycle and recover already produced devices. A secondary aim of WEEE directives is an increase of companies' environmental interests in manufacture, supply and usage and in recycle and reuse of electrical and electronic equipment. (Mlejnek, 2012).

Growing environmental concern has a large share on the increasing public awareness of the necessity to recycle IT and other electronic devices due to the presence of contaminants, such as lead and cadmium, and other toxic substances. The awareness is growing together with the increasing quantity of WEEE caused by lower prices and innovation speed. Despite of the growing awareness, Ongondo et al. (2011) demonstrates that the speed of introducing and implementing legislation dealing with WEEE is slow, moreover, absent in some cases.

The last recommended Green IT initiative for SMEs within the area is equipment disposal. This initiative can be taken as mandatory as it is enforced by the European legislation. The WEEE directives state that the disposal of electronic equipment is no longer the responsibility of the end-user. It is the manufacturer and dealer who should pay for the collection and recycling or disposal of this equipment at the end of its service life. Some countries, for example the United States of America, Canada or Japan, introduced and implemented a recycling fee, which is included in the price when buying new electrical devices. Vendor's obligation to withdraw old devices from his customers arises after the payment of the recycling fee. Hong and Ke (2011) pointed out that EPA obligates

manufacturers, importers and suppliers to pay Advance Recycling Fee (ARF) if they sell a new product to consumers. Moreover, EPA implemented subsidies for companies who recycle end-of-life electronic and electrical devices. The system of ARF works also in other countries, for example in Netherlands, Norway, Sweden and Switzerland. ARF for mobile phones is implemented in Australia. (Hong & Ke, 2011). Advance Recycling Fee or Advance Disposal Fee cuts emissions, green house gases and reduces waste disposal where it represents the most economical policy. (Acuff & Kaffinem, 2013).

2.5.Green by IT

The area of Green by IT is the second major area of Green IT. This area represents derived impacts of IT and it is mainly related to the introduction and the use of ICT applications and services, with business processes and governance. Today, companies have already perceived the need for 'green measures' and they are a subject to the increasing pressure from regulators, customers and investors. At the same time, they lack the appropriate systems to monitor the environmental impact of their activities, particularly in the form of expansion modules to existing Enterprise Resource Planning (ERP) systems that typically deal with the manufacturing, logistics, inventory, invoicing, accounting and distribution for companies. (Zeng et al., 2012).

More favourable environmental impact could be achieved through better management of business processes, which assumes modelling and description of business processes, reengineering processes, optimal support of processes by ICT services, and monitoring and measurement of processes with the aim of continuous improvement. ICT applications and services play an important role in all these activities. Another area is called teleworking, in other words, remote working and its options and collaboration tools. At the highest level it is governance ensuring that the integration of individual initiatives and efficient management is provided. (Buchalcevová et al., 2011).

2.5.1. Travel reductions

Mlejnek (2012) describes several ICT solutions that allow people to arrange a meeting, although they are not physically in the same office or even in the same country. Therefore, this could reduce the need for business travel. Those solutions consist of audio conferences, video conferences, on-line meetings or internet conferences and telepresences, which allow people to talk face to face without noticeable audio or visual delay. If a company does not use any of the above options, they should consider its introduction. If the company already uses some of the above, it is also possible to maximize the benefits by some of these options:

- Assurances that workers know how to use the equipment, providing educational lectures, demonstration example and then sufficient support for any questions.
- In the case of Internet or telepresence conference room, it is appropriate to establish a reservation system to achieve an efficient use.
- Giving priorities to those who intend to use the room's equipment during a meeting.

- Implementation of a mandatory questionnaire as a part of the conference tool which users fill in with the number of participants, the approximate number of kilometres saved and means of transport, which would be used for the business travel.
- Consideration of a system of rewards as a motivation for reducing travels.
- Occasional survey among employees, in order to determine satisfaction with the conference tools. If employees see a meaningful disadvantages or barriers to the use of these tools, it is suitable to detect them and remove them.

2.5.2. Work from home

Many companies are in a favour of flexible working policies and a large part of them have even more than 50% of employees working from home on a daily basis. For such a successful flexible working policy the company is highly dependent on a number of technologies that are largely shared with the initiative of travel reductions. However, these technologies still need to be supplemented by a robust system of remote control and access through a web interface to allow employees to perform all their daily work. This solution brings many advantages, for example, better work balance of individual employees, decreased travel costs or decreased need for offices. However, if offices are not adapted to have less energy consumption at smaller number of employees, then working from home could be disadvantageous for the environment since the employee consumes the energy at home as well. (Mlejnek, 2012).

2.5.3. Reducing resource consumption

ICT can play a significant role in the dematerialization of many everyday activities and processes in the company, in order to reduce their impact on the environment. This means for a company to think about the existing business processes and identify where changes can be made in order to reduce the consumption of used resources. Processes that could be made more effective are, for example, billing, payslips, faxing or printing.

It is advantageous for all businesses to send invoices in PDF format by e-mail, instead of sending in paper form by mail. Larger companies may also consider the option of introducing a billing system that will automatically send electronic invoices. Payslips are in a similar position as invoices. There is no need to print them when you just sent them in an electronic form to each employee’s e-mail. The switch from the traditional sending documents "from a fax to a fax" to "from a fax to an e-mail" is not a problem at this time and it saves more energy and paper.

There is a wide range of other processes and activities that could be optimized within the enterprise and made more effective precisely because of the use of ICT. It takes more than management of a company. In most cases it is the operational processes which needs to be optimized, therefore, consultation with managers or directly with operational employees is needed. (Mlejnek, 2012).

2.5.4. Building automation

Another area of 'Green by IT' is building automation. ICTs have the capabilities of automatically manage buildings, mainly in order to reduce the energy consumption. Building automation programs can control the electricity consumption in offices, automatically reduce heating and switch off the lights in rooms where there are no workers at that moment. Sensors enabling this function can be provided in each room and they can be separately controlled. The energy savings could range at high values. Origins of the building automation initiative dates back in 1990 when the first method was introduced. The Building Research Establishment Environmental Assessment Method (BREEAM) evaluates and checks building performance using environmental standards and criteria. (Ding, 2008).

Wireless sensor and control networks (WSN) enable companies to automatically manage the indoor environment with computer software. Temperature control program has the aim of controlling and slowly changing the air temperature in a room using heating, ventilator and air conditioners. Illumination control program manage the lights, on the other hand, very quickly with regard to the sunshine intensity. (Ploennings et al., 2010).

2.5.5. Measuring and monitoring

Measuring and monitoring within the Green IT is meant primarily as a measurement of the energy consumption and carbon footprint calculation. Basically it is an indispensable area for any business that intends to give more attention to Green IT, since only by measuring and monitoring it is possible to evaluate the benefits of implemented solutions. (Mlejnek, 2012).

The act of measuring the energy consumption and CO2 emissions calculation itself requires the use of information and communication technologies whether companies use only simple spreadsheet software (e.g. Microsoft Excel) for recording and comparing different areas of the company, or they use sophisticated systems for measuring and monitoring energy consumption and carbon footprint calculation. The carbon footprint is calculated as individual's or company's impact on the planet. The sum includes data from facilities, operations and purchases, travelling and transportation and also the amount of created greenhouse gases should be included. (Velte et al., 2008).

2.6.Environmental management systems

Environmental management systems (EMS) are a component of an integrated management system organization guided by standards which are developed by the International Organization for Standardization (ISO). EMS manages organization requirements in terms of the environment, focusing on the prevention, control of pollution and environmental protection. The best known international environmental management standard ISO 14001 or standard Eco Management and Audit Scheme (EMAS) applied to the European Union is a start towards managing the sustainable development. (Doucek et al., 2011).

Why should companies register under EMAS or be certified to ISO 14001? Richard Clemens, one of designers of the ISO 14000 series, affirms that investors, customers and local

environment like to see the company registered as complying with an international environmental standard. It may be a huge marketing advantage. (Clemens, 1997).

Companies consider how the elements of the standard are applied within the business context but ISO 14001 does not command it. SMEs derive ideas from Plan-Do-Check-Act management concept, shown in the Figure 2.2, for performance improvement. It provides schematic expression of the whole life cycle of EMS or its components while it also provides the feedback. (Doucek et al., 2011).

Figure 2.2 - Plan-Do-Check-Act cycle (EC, 2012)

2.6.1. Benefits of adopting EMSs

There are several benefits from the EMS implementation. Those benefits are grouped in many categories and they can be related to the internal or the external interactions and SMEs operations. Most of them are included in organisational internal benefits such as the improvement of training, working conditions, the quality of environmental information and procedures. Other benefits result from the decreased costs from material or from the energy and waste reduction. Moreover those advantages motivate employees to improve their knowledge, skills, morale and provide a better company image. Positive public image cohere with external benefits, such as gaining competitive marketing advantages and therefore new customers, improving environmental performance with reducing pollution or increasing energy and material efficiencies. Companies with adopted EMS set an example for other firms but they also might have struggled with barriers of the adoption or disadvantages such as a time and costs requirements to implement an EMS. (Hillary, 2000).

The first small enterprise in the UK that became registered under EMAS was Loudwater, a printing company. By waste and energy consumption reducing, recycling or selling their unavoidable waste they have saved in excess of £20,000. (Hillary, 2000).

A small accountancy company D.A. Millington replaced their daily-based knowledge sources of the latest legal requirements printed on a paper with Internet-based information. That has saved them over 1% of their annual turnover. (Hillary, 2000).

2.6.2. Barriers to the adoption of EMSs

Arising barriers within the companies could hamper or prevent EMS adoption. Lack of time for maintenance, lack of technical knowledge and skills or training, lack of staff, uncertainty about the effectiveness of EMSs to achieve the objectives, those are the major internal barriers but in most cases SMEs are ill-informed about maintaining this improvement and what benefits could be achieved from the adoption. External barriers consist mainly of high demands for the support and guidance. Certification costs could be too high for smaller organization and the situation could be complicated by a limited access to the financial support. Another barrier lies in the need of hiring external guidance to introduce and implement the system. (Hillary, 2000).

3. Methodological bases and questionnaire research tools

3.1.Introduction

This chapter' objective is to introduce the research method used for data collection. Collected data are used to analyze four research objectives, which are:

- To examine and evaluate the awareness and application of Green IT amongst IT managers, network administrators or company directors of SMEs;
- To find possible areas of strong and weak scopes of Green IT;
- To compare those areas of Green IT and find out possible connection to the number of employees of a company or its business sector;
- To examine differences between SMEs located in the United Kingdom and SMEs located in Czech Republic.

At the same time, collected data are used to confirm or disprove four determined hypotheses:

- 40 % of participating companies never heard about environmental management systems
- 50 % of participating companies heard about carbon footprint calculation but they do not plan to implement this option
- There is a link between the implementation of EMS systems and the number of employees in the company
- 70 % of participating companies provide resources for Green IT activities that do not require high additional costs and they are not time consuming. Those activities include computers power settings, equipment consolidation, storage optimization, interaction with employees, reducing paper consumption, green devices purchase, recycling and disposal under the WEEE Directive.

Main advantages and disadvantages of the research method are described in this chapter together with the explanation why the method was chosen and how it was built. At the end of this chapter the limitations of chosen method are described.

3.2.Choosing a research method

The chosen research method for data collection is a questionnaire sent via e-mail with embedded URL address. Questionnaire collection enables to obtain a large amount of information, therefore this method was chosen because of the need to compare results from a large number of SMEs. E-mails with embedded hyperlink enable respondents to access the questionnaire by clicking on the URL address given in the e-mail invitation. This way is completely anonymous, which could be more comfortable option for many respondents.

On-line version of questionnaires has many advantages comparing to questionnaires sent by post. Those advantages lie in zero implementation costs since there is no need to print the

questionnaires, to buy envelopes and to pay for the postage (the cost of electricity is not included). Moreover, Ranchhod & Zhou (2001) highlight that, in the case of physical mail, lower response rate could be caused by the unwillingness of companies to respond if the researcher does not send the questionnaire together with an addressed envelope and a stamp. The whole process of sending a questionnaire via e-mail is less time-consuming due to decreased physical efforts to stuff and address envelopes, it is possible to gather large amount of data in a short period of time and after the collection the results comparison is much easier and faster. In addition, on-line version was chosen for its lower impact on the environment.

Poor response rate is considered to be the biggest disadvantage of on-line questionnaire research. The expected rate is usually very low, only about 10% in most cases. (Ranchhod & Zhou, 2001). Other disadvantage lies in pre-coded questions. This constitutes more likely a disadvantage for respondents rather than for a researcher. Respondents can feel discouraged to answer questions with a list of possible answers if their answer differs from answers suggested by the researcher. (Denscombe, 1998). On the other hand, this can count as an advantage for the researcher because it is easier to compare results from questionnaires without open answers. However, even if the response rate was high and results were easy to compare, researcher cannot check the truth of answer since questionnaires are usually anonymous.

3.3.Design of questionnaire

The questionnaire consists of 22 closed questions with a list of suggested answers where only one option is allowed to choose. The questions are divided into two parts. The first part of the questionnaire contains two questions and they investigate basic information about the company – the number of employees and business sector. The list of possible answers for the number of employees was compiled according to the EC recommendation for defining SMEs, which says micro businesses employ up to 10 people, small businesses up to 50 people and medium businesses up to 250 people. There is one other possible option to choose - more than 250 employees. This option aims to eliminate large businesses from affecting the questionnaire results. The second question of the first part finds the area of business. The list of possible answers was compiled according to the Office for National Statistics (2012) which determines 16 business sectors: agriculture, forestry & fishing; production & manufacturing; mining, quarrying & utilities; construction; wholesale and retail, repair of motor vehicles; transport & storage (inc. postal); accommodation & food services; information & communication; finance & insurance; property; professional, scientific & technical; business administration and support services; public administration and defence; education; health; arts, entertainment, recreation and other services.

The second part of the questionnaire contains twenty questions focused on knowledge and usage of Green IT. Respondents are asked to answer questions with two kinds of possible answers. The first type is only to examine whether or not is Green IT used and the second

type furthermore examines to what extent Green IT is used and whether the companies measure benefits and continuously perform measurement-based optimization.

3.4.Data collection

The questionnaire was sent by e-mail with embedded URL address to 321 IT managers, network administrator or company directors of SMEs based in the United Kingdom and to 279 SMEs in Czech Republic. It was tried to contact companies which are based in different regions and which operate in different business sectors. The questionnaire was sent in March 2013 and the process of data collection took two weeks.

3.5.Pilot study

The questionnaire was tested on 5 SMEs before sending it out via e-mails in order to check if the questions and answers are clear and easy to understand. After getting a feedback the questionnaire was consulted with researcher's tutor in UK at University of Huddersfield and then translated to Czech language and sent by e-mail to researcher's tutor at Vysoká škola Báňská – Technical University of Ostrava in order to consult the questionnaire structure. No changes were made and the questionnaire was sent out.

3.6.The limitations of study

Michaelidou & Dibb (2006) maintain that it is important to carefully target the sampling frame. Response rates might decrease if the topic is not relevant or interesting for respondents or they do not have sufficient knowledge required to answer selected questions. Research objectives of this survey are focused on the scope of Green IT. Since these topics fall in technical area, suitable respondent would be company's IT manager or network administrator. However, companies with a small number of employees, for example companies with only up to 10 employees, do not usually use multiple number of IT office equipment, such as PCs, printers or faxes, therefore this questionnaire is not relevant for them. Although, if a company use multiple number of this equipment but still employs a small number of people, they do not have to run an IT department or employ any person responsible for IT management. In some cases the company director could also work as an IT manager. Therefore, in order to find suitable respondents, SMEs employees e-mail addresses were searched for individually, which complicated the examination process and reduce the chance of finding quality and relevant information.

The relatively high number of questions could be the cause of the decreased response rate because respondents would not be willing to spend time on completing long questionnaires; on the other hand, reasonably low number of questions does not allow a deeper insight into the topic. Another reason of the decreased response rate could also be inadequate timing of conducting research – Easter holidays, or the short period of time waiting for responses.

Also it is impossible to examine all SMEs based in the United Kingdom and Czech Republic, or SMEs operating in all possible business areas. Other limitations of this research lie in the absence of questions connected to the director's or responsible manager's opinions and

views of environmental protection and questions connected to the financial situation and financial resources available to invest in Green IT. Also companies situated in areas with poor environmental conditions might be more interested in the environmental protection more than similar businesses situated in areas where the environment is not discussed on a larger scale.

4. Realization of research

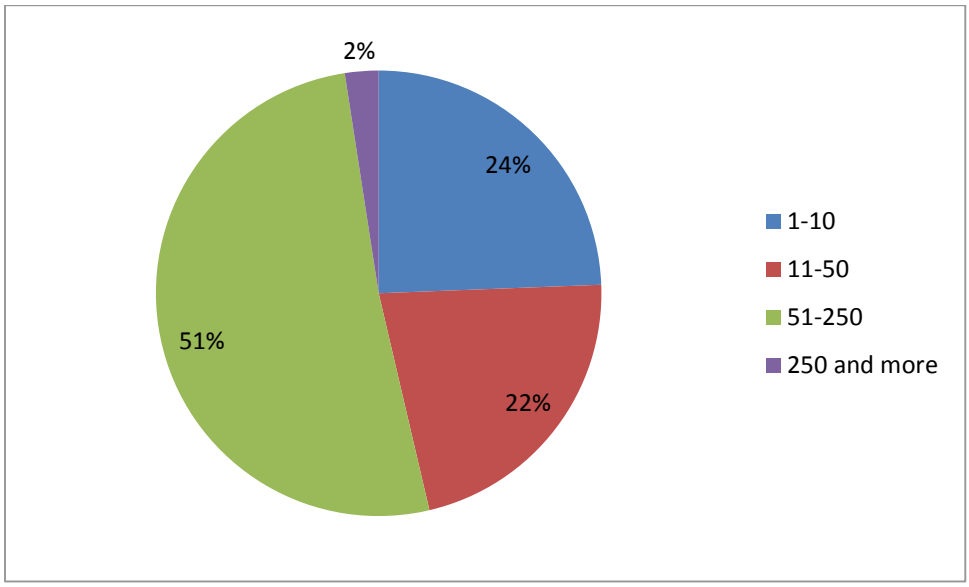
This chapter presents the questionnaire's results. The research was conducted amongst small and medium-sized companies in the United Kingdom and Czech Republic. The chapter is divided into two main parts. The first part presents the profile of participating companies that was examined in the question one and two. The second part compares results of the Czech respondents with results of the English respondents and it aims to prepare a background for meeting the research objectives which is discussed in the sixth chapter - Discussion.

4.1.Profile of respondents

From the 600 questionnaires distributed to companies from both countries, 85 were returned and the response rate was 14.17%. From the 321 questionnaires sent to SMEs situated in the United Kingdom, 41 were filled and the response rate was 12.77%. Chart 4.1 shows the count of participating companies from the United Kingdom and the number of individual types of companies according to their number of employees. Only one company with more than 250 employees (2%) filled the questionnaire and its answers were not taken into account. 10 micro businesses (24%), 9 small businesses (22%) and 21 medium-sized businesses (51%) participated in the research for SMEs operating in the United Kingdom.

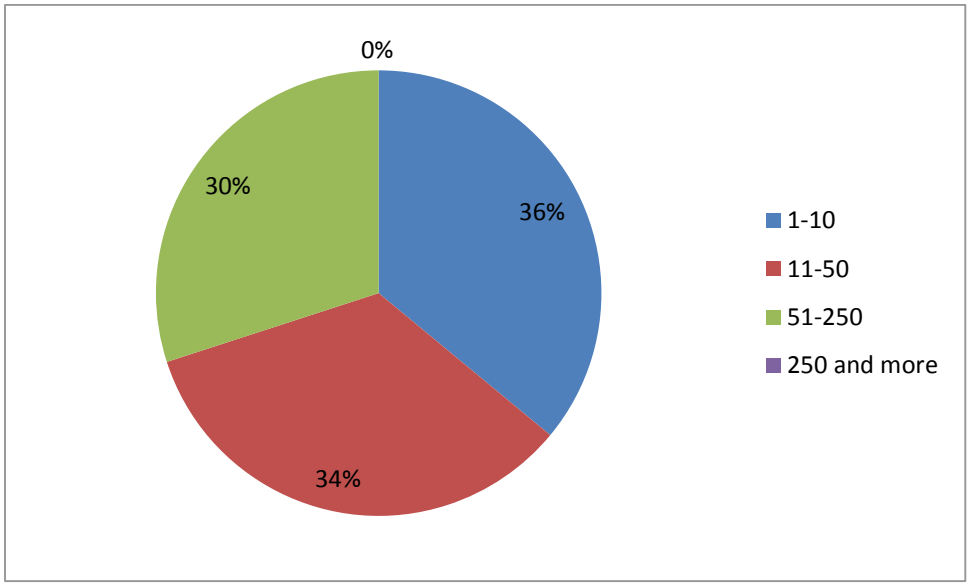
Question No. 1

Chart 4.1 - Profile of the respondents from the United Kingdom



The response rate of SMEs situated in Czech Republic was higher; 279 questionnaires were sent out and 44 were filled therefore the response rate was 15.77%. Chart 4.2 shows the count of participating companies from Czech Republic and the number of individual types of companies according to their number of employees. 16 micro businesses (36%), 15 small businesses (34%) and 13 medium-sized businesses (30%) participated in research for SMEs operating in Czech Republic.

Chart 4.2 - Profile of the respondents from Czech Republic



Question No. 2

The numbers of participating companies' business sectors are shown in Table 4.1. Most of the respondents from the United Kingdom operate in construction or business administration and support services (14.64%). Accommodation and food services were represented by four companies (9.76%). Other business areas represented by four respondents were finance and insurance; health and information and communication. Education was represented by three respondents (7.31%) and areas represented by two respondents (4.88%) were agriculture, forestry and fishing; art, entertainment recreation and other services; professional scientific and technical and wholesale and retail, repair of motor vehicles. Areas represented by one respondent (2.44%) were mining, quarrying and utilities and the area of property. Areas that were not represented are manufacturing; production and manufacturing; public administration and defence and transport and storage (inc. postal).

On the other hand, most of the respondents from Czech Republic operate in construction or manufacturing area (20.45%). Other more represented area was information and communication with six respondents (13.64%) property was represented by five respondents (11.36%) and the area of health was represented by four respondents (9.1%) Areas represented by three respondents (6.81%) were business administration and support services and finance and insurance. Areas represented by two respondents (4.55%) agriculture, forestry and fishing and production and manufacturing. Wholesale and retail, repair of motor vehicles was represented by one respondent (2.27%). Areas that were not represented are accommodation and food services; art, entertainment, recreation and other services; education; mining, quarrying and utilities; professional scientific and technical; public administration and defence and transport and storage (inc. postal).

Table 4.1 – Business sectors

Business sector	The United Kingdom	Czech Republic
accommodation and food services	4	0
agriculture, forestry and fishing	2	2
arts, entertainment, recreation and other services	2	0
business administration and support services	6	3
construction	6	9
education	3	0
finance and insurance	4	3
health	4	4
information and communication	4	6
manufacturing	0	9
mining, quarrying and utilities	1	0
production and manufacturing	0	2
professional scientific and technical	2	0
property	1	5
public administration and defence	0	0
transport and storage (inc. postal)	0	0
wholesale and retail; repair of motor vehicles	2	1

4.2.Results on the issue of Green IT

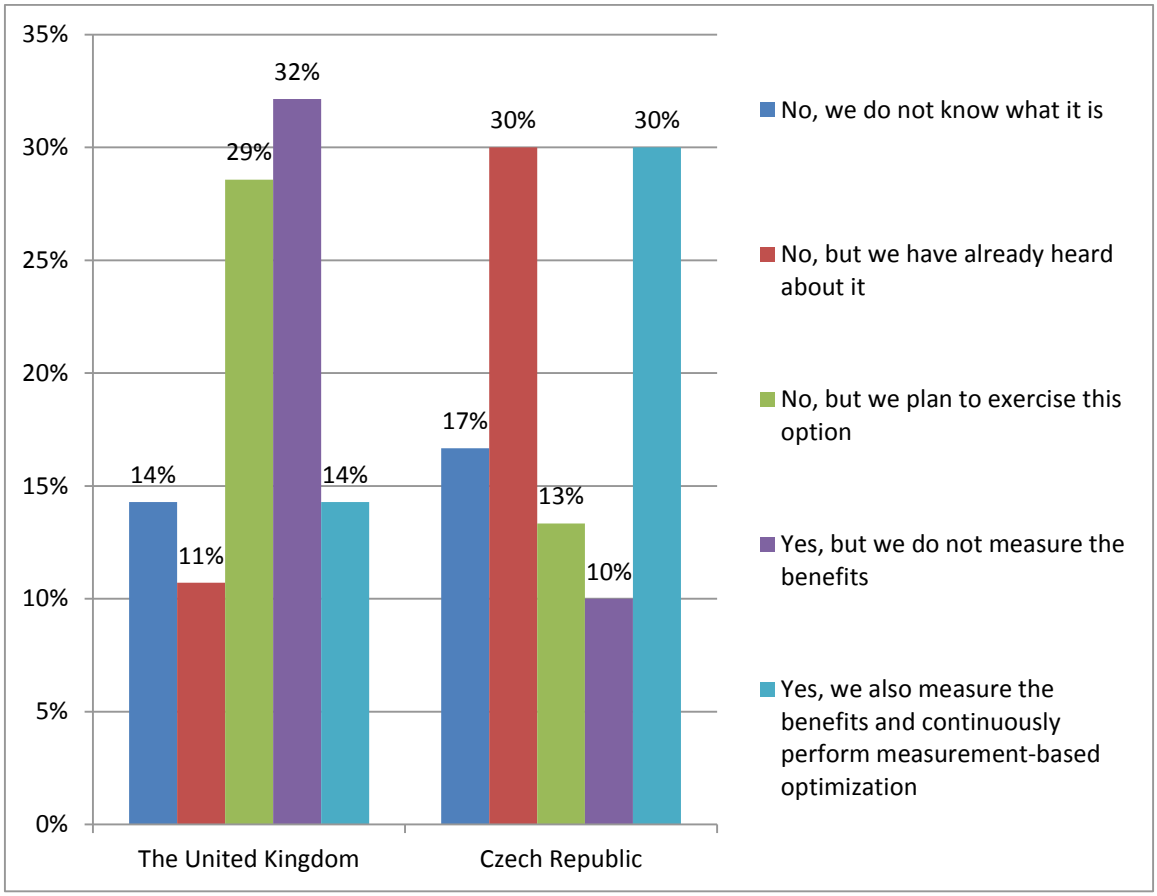
Question No. 3

This question examined whether the company use one of the following options: server consolidation, virtualization or cloud computing.

14% of English participating companies never heard about it, 11% respondents already heard about it but they do not use it, 29% plan to exercise this option. 46% participating English companies already use one of these options but only four of those companies (14%) also measure the benefits and continuously perform measurement-based optimization.

Results from Czech Republic are relatively similar. 17% of participating companies never heard about it, 30% of respondents already heard about it but they do not plan to exercise this option. 13% plan to exercise this option. 40% of respondents participating Czech companies already use one of these options and 30% of respondents measure the benefits and continuously perform measurement-based optimization.

Chart 4.3 - Use of server consolidation, virtualization or cloud computing



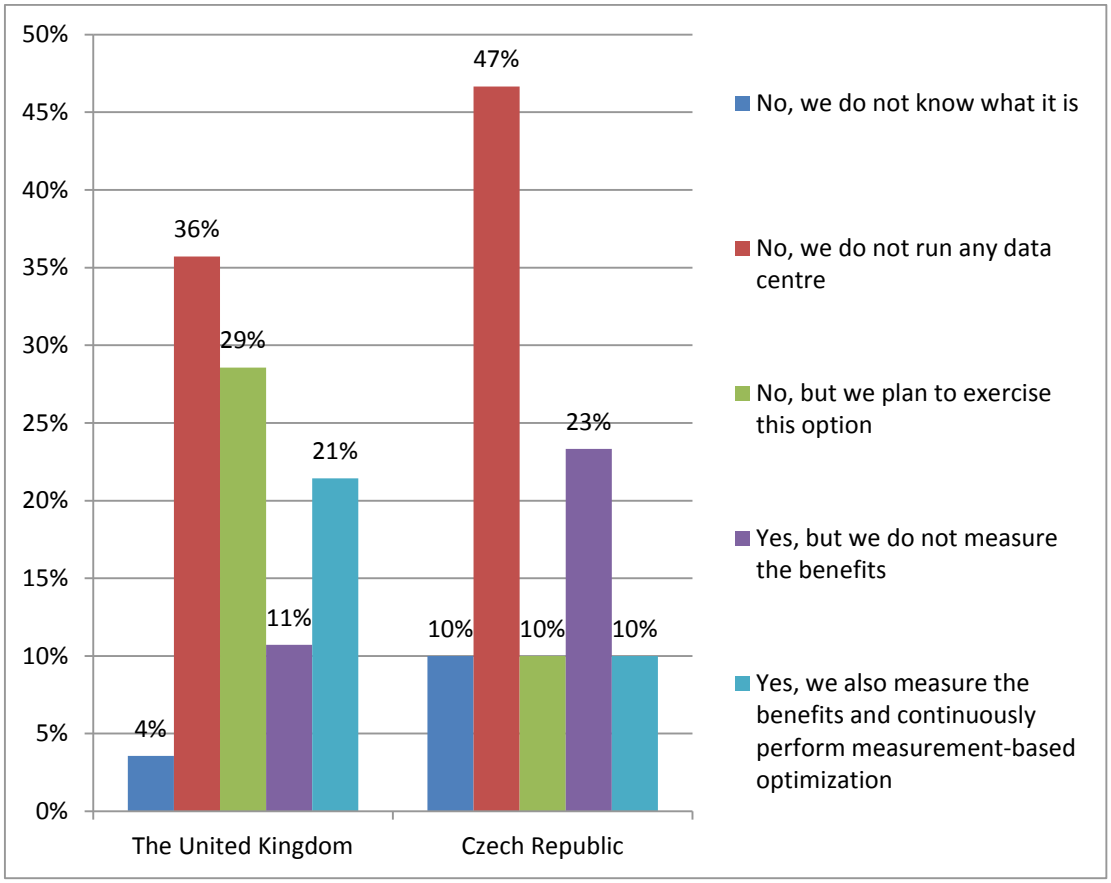
Question No. 4

Fourth question examined the issue of data centre optimization. The results showed that most of the participating companies do not run any data centre. 36% English and 47% Czech participating companies chose this answer.

29% of the English respondents plan to optimize their data centre. 11% of the English respondents perform optimization and 21% of the English respondents moreover measure benefits and continuously perform measurement-based optimization.

10% Czech respondents plan the data centre optimization, 23% of the Czech respondents already perform optimization and 10% of the Czech respondents also measure benefits and continuously perform measurement-based optimization.

Chart 4.4 - Data centre optimization



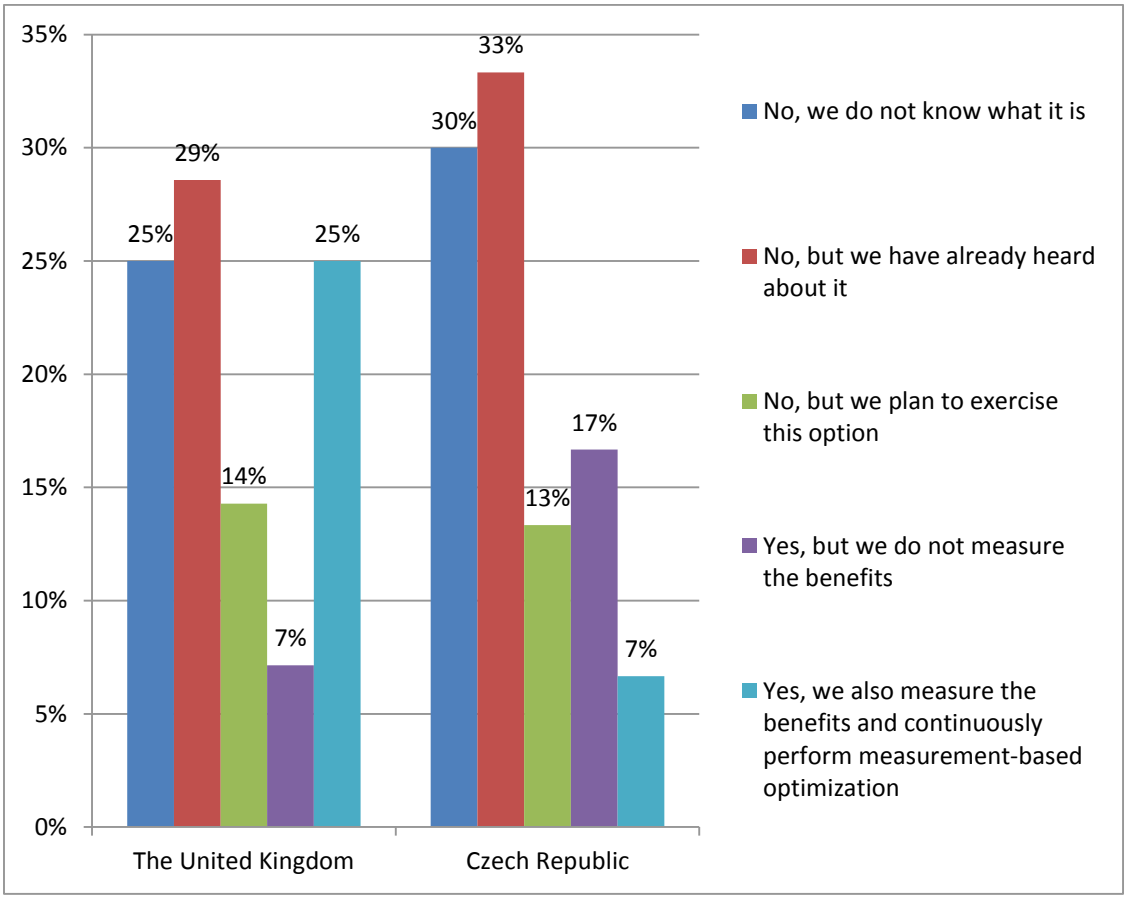
Question No. 5

The use of thin clients was examined in this question. The results showed that more than a half of participating companies from both countries do not know what thin clients are or they heard about them but do not plan to use them. In sum, 54% of the English respondents and 63% of the Czech respondents chose one of those answers. The results of this question are similar for both countries with one exception in percentage of companies who use thin clients and also measure the benefits.

14% of the English respondents plan to exercise this option. 32% of the English respondents already implemented the use of thin clients and other 25% of respondents also measure benefits and continuously perform measurement-based optimization.

13% of the Czech respondents plan to implement them, 24% of the Czech respondents already use them however only 7% of the Czech respondents measure benefits and continuously perform measurement-based optimization.

Chart 4.5 - The use of thin clients



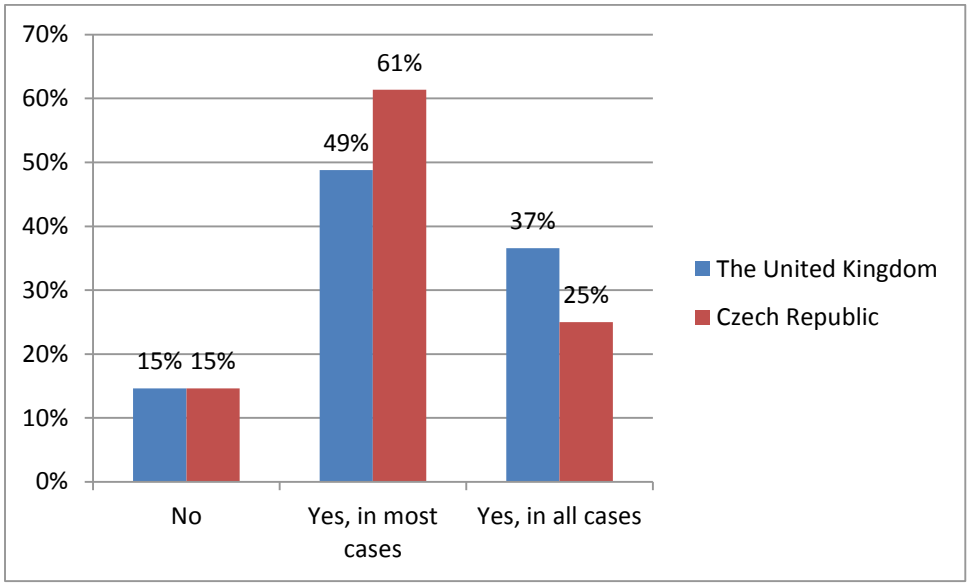
Question No. 6

Storage optimization and data storage solutions were examined in this question. SMEs from both countries were represented by 6 respondents who do not compress data or move unused data to the backup disks which account for 15% of the respondents from both countries.

20 English respondents (49%) use this option in most cases and 15 English respondents (37%) in all cases.

This option is used by 27 Czech respondents (61%) in most cases and by 11 Czech respondents (25%) in all cases.

Chart 4.6 - Storage optimization

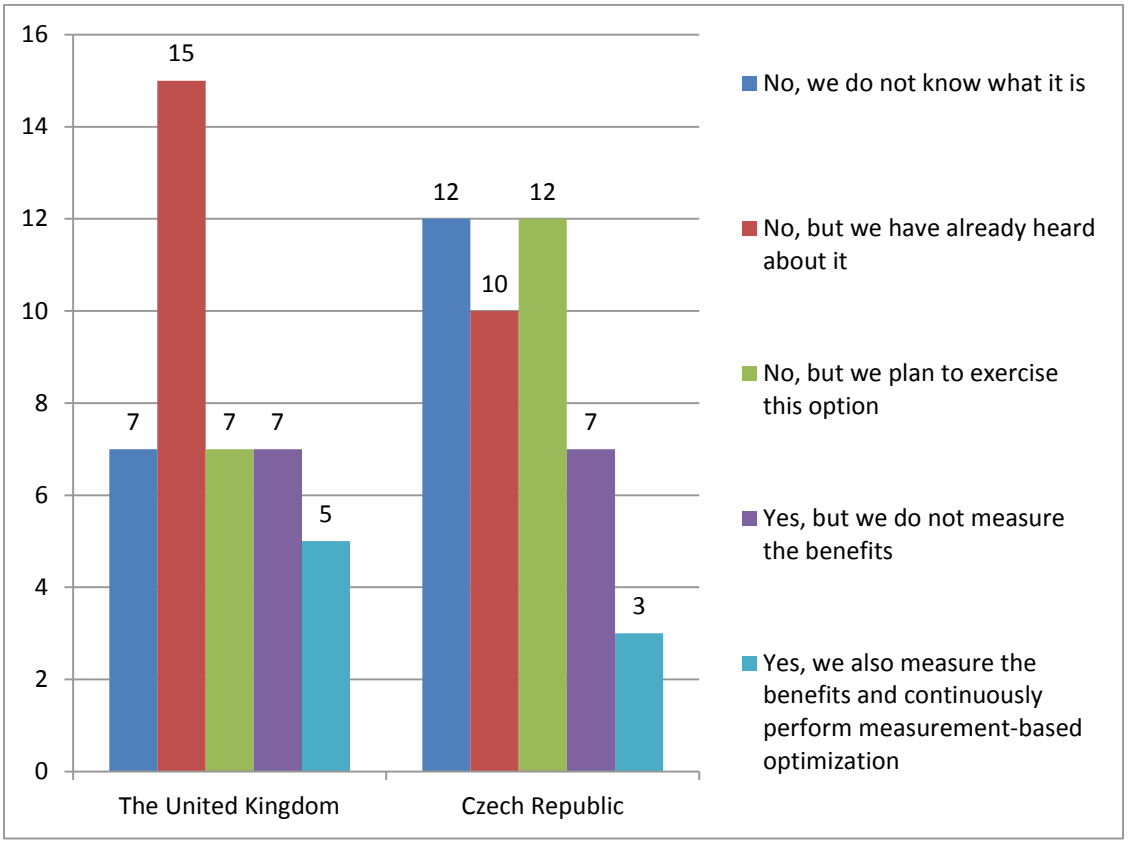


Question No. 7

This question has found that 7 respondents (17%) from SMEs operating in the United Kingdom do not know what Automated Power Management Systems are, 15 respondents (37%) already heard about them and 7 respondents (17%) plan to exercise them. Other 7 respondents (17%) use them but do not measure benefits and 5 respondents (12%) also measure the benefits and continuously perform measurement-based optimization.

12 respondents (27%) from Czech Republic do not know Automated Power Management Systems, 10 respondents (23%) already heard about them and 12 respondents (27%) plan to implement them. 7 respondents (16%) use them and three of them measure the benefits and continuously perform measurement-based optimization.

Chart 4.7 - Automated Power Management Systems



Question No. 8 and question No. 9

Chart 4.8 and Chart 4.9 show respondents' answers about the basic power settings of their office equipment.

7% of the English respondents did not set any time period after their monitor and disks are shut down. 54% of the English respondents stated that most of their equipment is set to shut down after 15 minutes or less of inactivity and 39% of respondents have all the equipment set to shut down after 15 minutes or less of inactivity.

17% of the Czech respondents did not set any time period after their monitor and disks are shut down. 40% of respondents have most of their equipment set to shut down after 15 minutes or less of inactivity and 37% of respondents use this option in all cases.

Chart 4.8 - Equipment basic settings in the UK

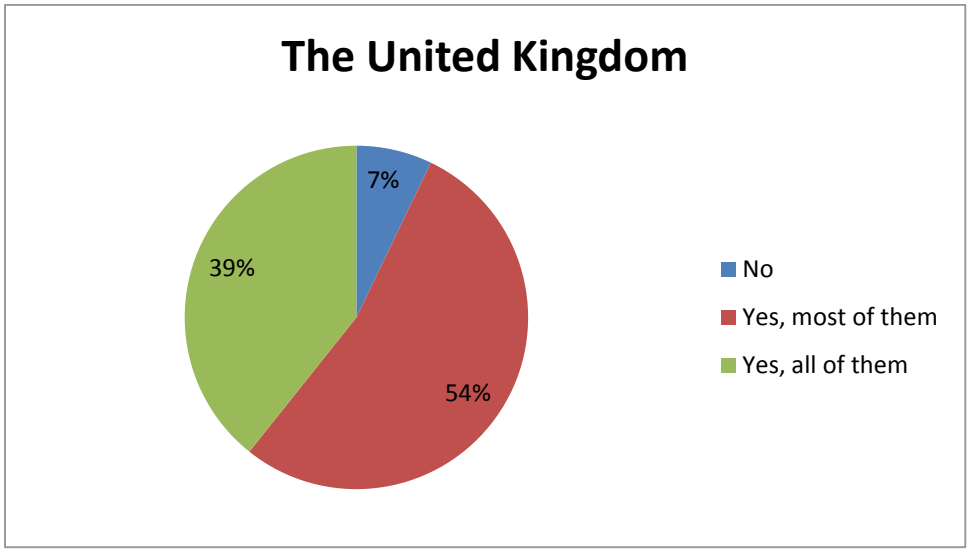


Chart 4.9 - Equipment basic setting in Czech Republic

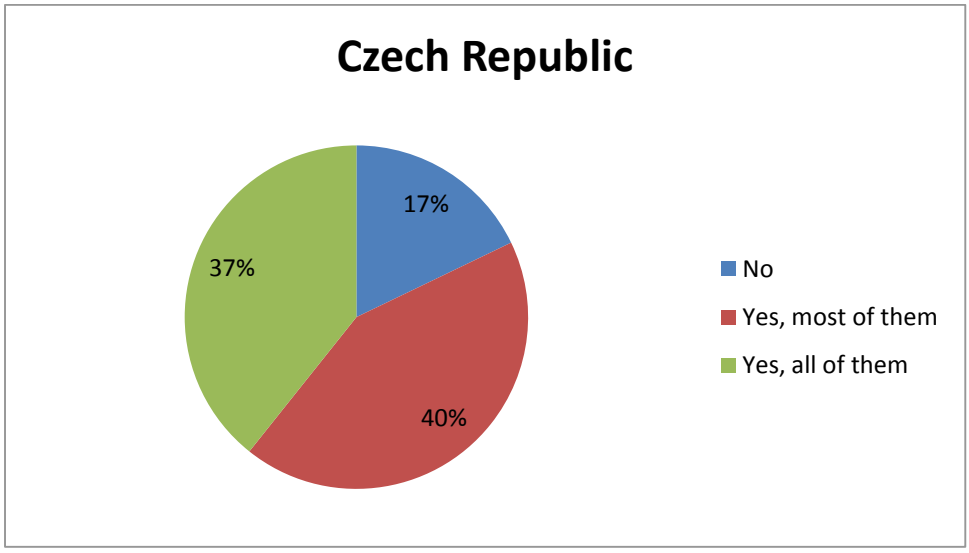


Chart 4.10 and Chart 4.11 show respondents' answers about the basic power settings of their personal devices – computers and laptops.

11% SMEs based in the United Kingdom did not set any time period for their computers and laptops to switch to hibernation. 57% English of the used set 30 minutes or less of inactivity in most cases and 32% of respondents in all cases.

13% of the Czech respondents do not use any power setting for their computers and laptops, 43% respondents set their devices to switch to hibernation after 30 minutes or less of inactivity in most cases and 37% of respondents in all cases.

Chart 4.10 - Personal devices basic setting in the UK

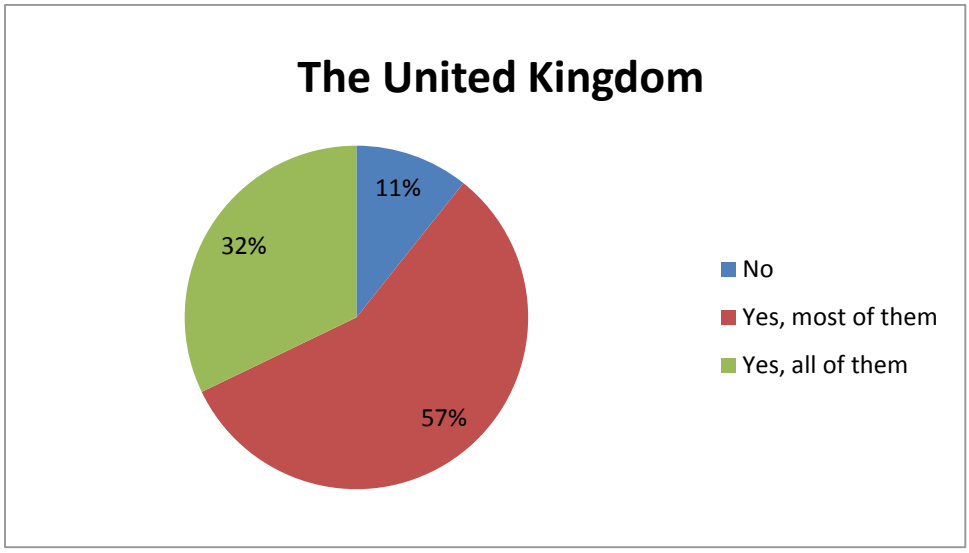
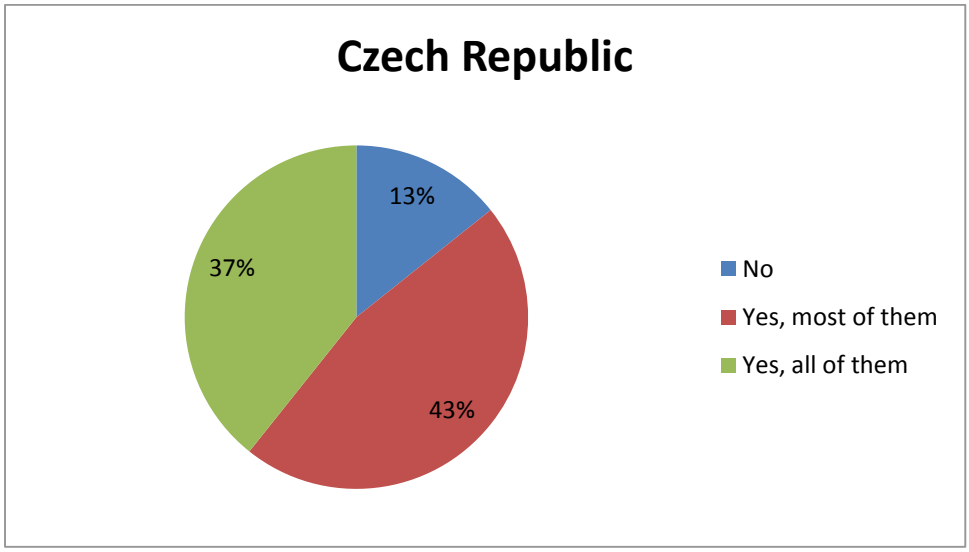


Chart 4.11 - Personal devices basic setting in Czech Republic



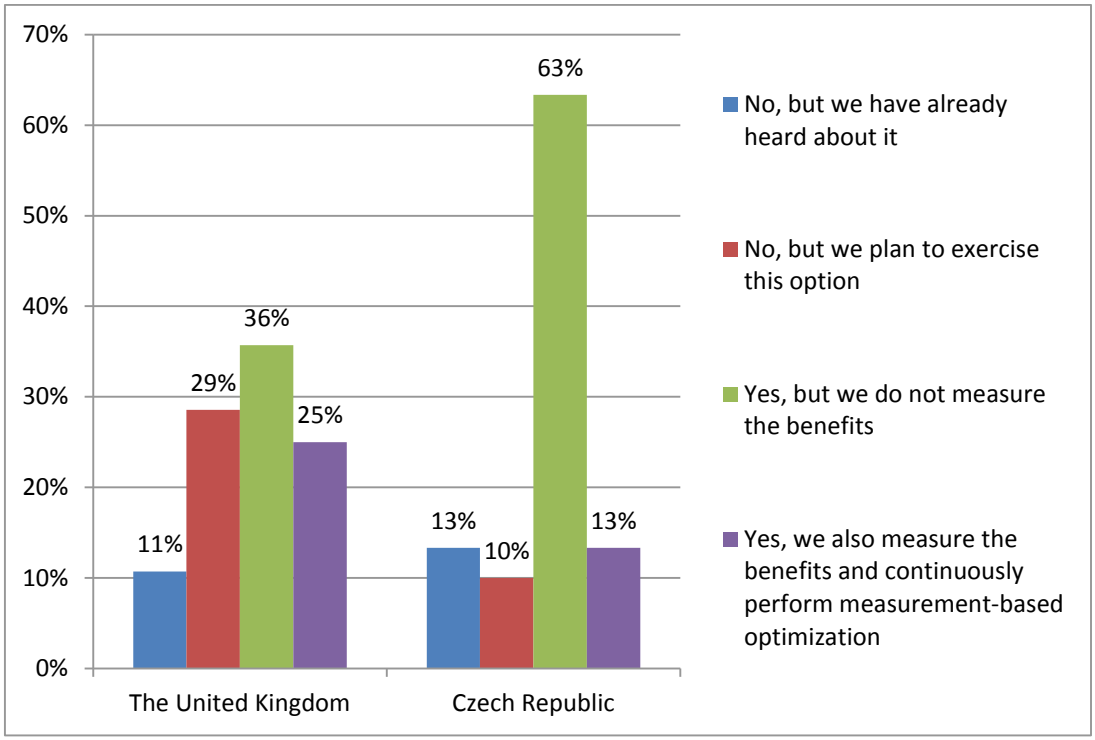
Question No. 10 and question No. 11

These two questions examined the awareness and application of office equipment, such as printers, and personal devices consolidation, for example laptops or computers.

11% of the English respondents stated that they already heard about consolidation of office equipment but they do not plan to exercise this option. 29% of the English respondents plan the consolidation and 61% of the English respondents use the ratio at least 10 employees per 1 device for their equipment consolidation.

13% of the Czech respondents know what office equipment consolidation is but they do not plan to exercise this option. 10% of the Czech respondents plan to implement this option and 76% of the Czech respondents use the ratio at least 10 employees per 1 device for their equipment consolidation.

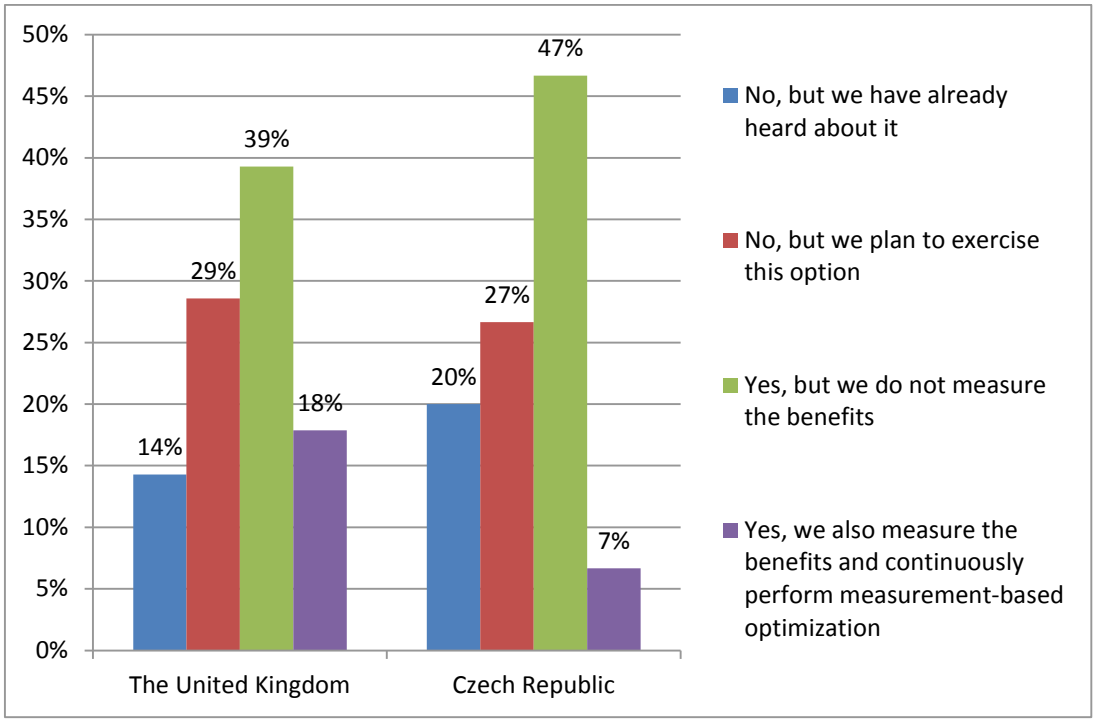
Chart 4.12 - Office equipment consolidation



14% of the English respondents answered that they heard about personal devices consolidation but they do not plan to exercise the option. 29% of respondents plan to consolidate their personal devices and 57% of the English respondents use the ratio at least 1 employee per 1 device for their personal devices consolidation.

20% of the Czech respondents answered that they heard about personal devices consolidation but they do not plan to exercise the option however 27% of respondents plan to implement this option. 54% of the Czech respondents use the ratio at least 1 employee per 1 device for their personal devices consolidation.

Chart 4.13 - Personal devices consolidation



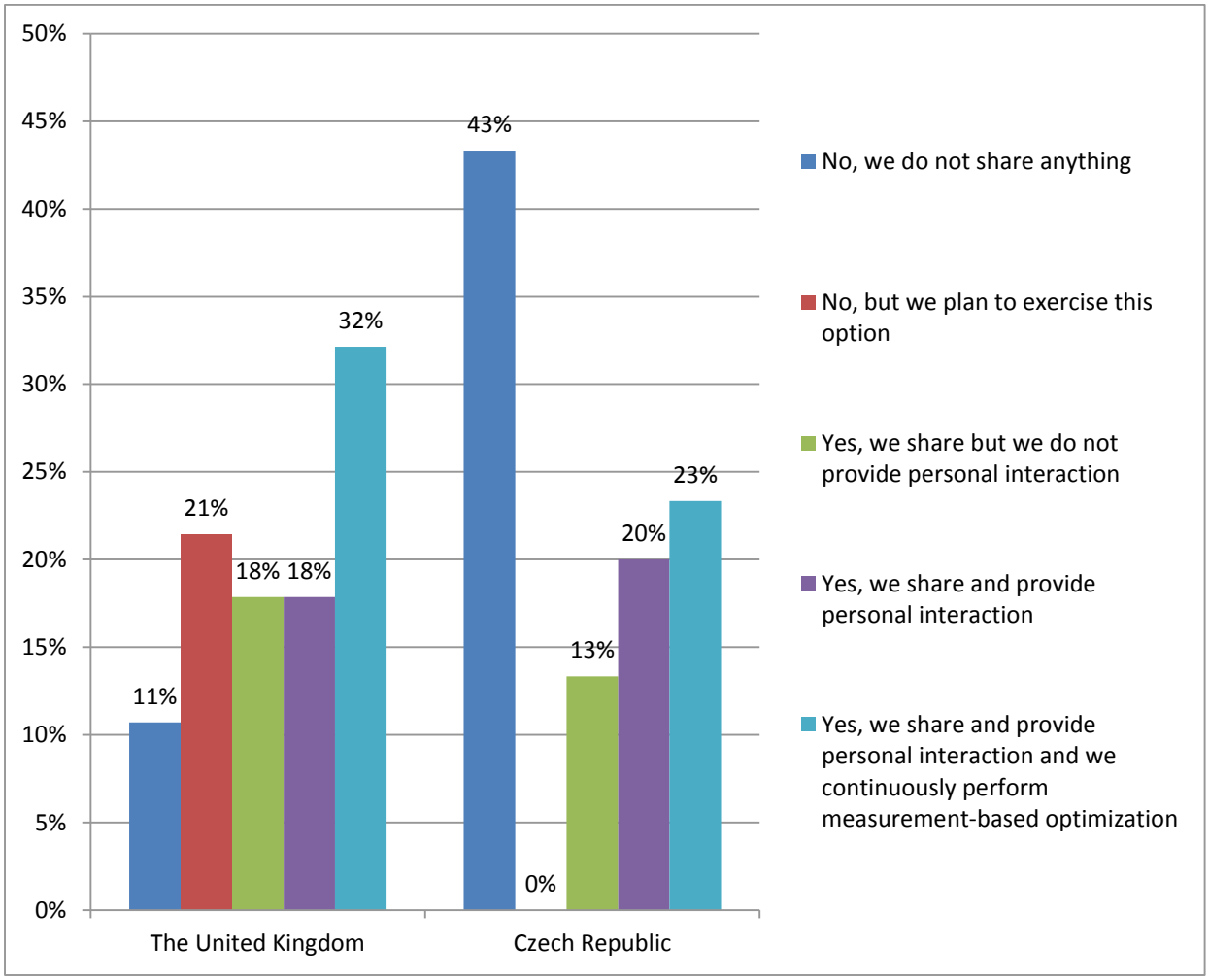
Question No. 12

In this question SMEs attitudes towards information, feedback and personal interaction with employees were examined.

Chart 4.14 shows that 11% of the English respondents do not share any information about their green activities, 21% want to implement this option. Information and feedback are shared without personal interaction in 18% of the English SMEs. In 18% of the English participating companies managers share information and provide personal interaction. 32% of the English respondents stated that they moreover continuously perform measurement-based optimization.

43% of the Czech respondents do not share any information about their green activities and no one from Czech respondent plan to exercise this option. 13% share information and feedback without personal interaction and 20% provide personal interaction. 23% of the Czech participating companies furthermore continuously perform measurement-based optimization.

Chart 4.14 - Information, feedback and personal interaction



Question No. 13 and question No. 14

These questions examined behaviour of SMEs employees concerning the usage of IT devices.

Table 4.2 shows whether employees of participating companies switch off their computers and monitors when it is not used and unplug notebooks and chargers and.

Table 4.2 – Employees behaviour

Answer	The United Kingdom		Czech Republic	
	percentage	count	percentage	count
No	7%	3	14%	6
Yes, most of them	54%	22	48%	21
Yes, all of them	39%	16	39%	17

Table 4.3 shows whether employees use the option of hibernation instead of screensavers.

Table 4.3 - Employees settings

Answer	The United Kingdom		Czech Republic	
	percentage	count	percentage	count
No	15%	6	20%	9
Yes, most of them	51%	21	52%	23
Yes, all of them	34%	14	27%	12

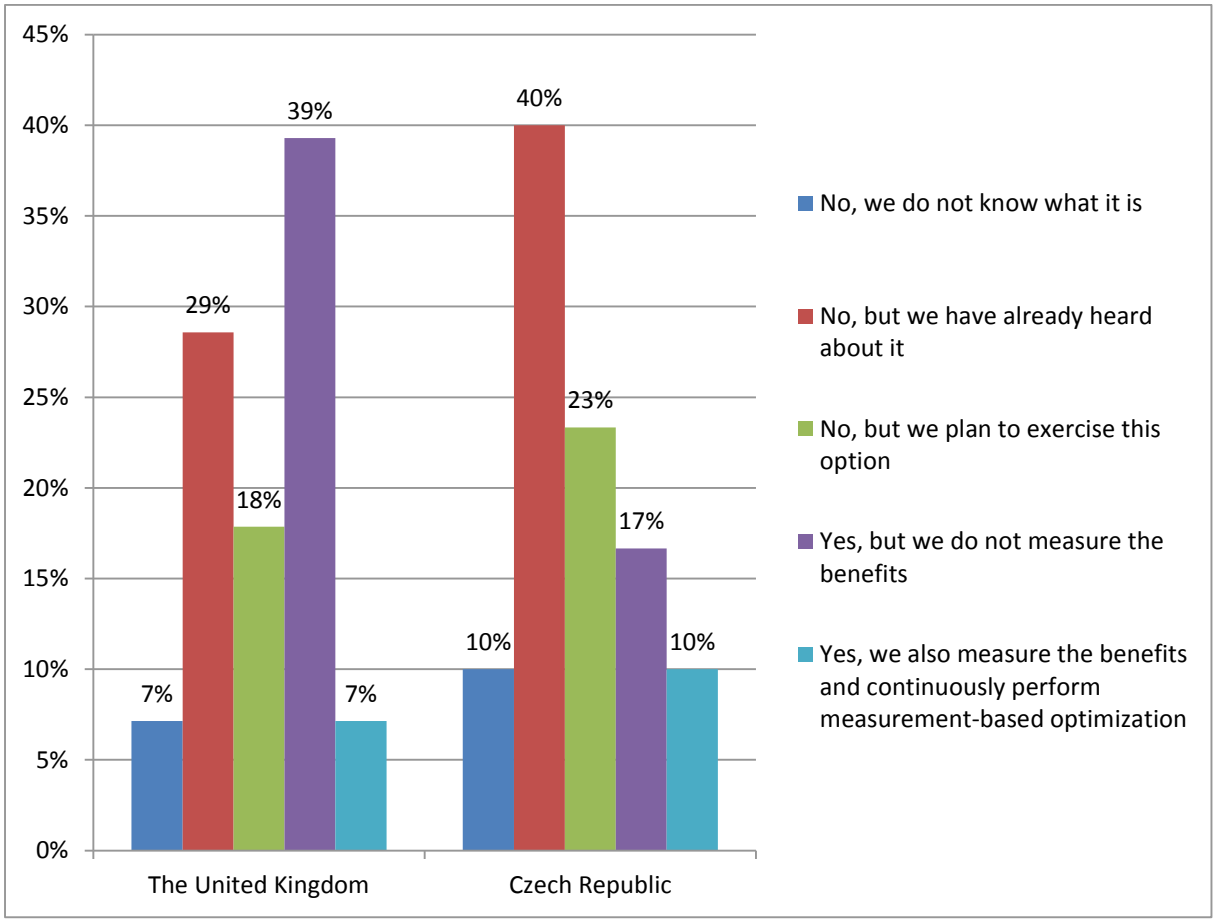
Question No. 15

This question examined the area of purchasing new equipment with regard to its suppliers. Companies were asked if they search for green devices when buying new ICT equipment, for example with energy labels, Energy Star or EPEAT.

7% of the English respondents did not know what that it, 29% stated that they only heard about it and 18% plan to exercise this option. In sum 46% of the English responents already use this option.

10% of the Czech respondents never heard about green devices, 40% answered that they know them but do not look for them and 23% plan to exercise this option. In case of Czech respondents only 27% of them already look for Green IT devices when they buy new equipment.

Chart 4.15 - Purchasing new ICT equipment



Question No. 16 and question No. 17

Handling with ICT devices was examined in these two questions.

Table 4.4 shows whether participating companies repair broken ICT device if the replacement is not necessary.

Table 4.4 - Choice of repairing broken ICT devices

Answer	The United Kingdom		Czech Republic	
	percentage	count	percentage	count
No	5%	2	16%	7
Yes, mostly	54%	22	50%	22
Yes, always	41%	17	34%	15

Table 4.5 shows whether participating companies donate unwanted ICT, recycle or reuse unwanted ICT devices and dispose it under the WEEE Directive.

Table 4.5- Handling unwanted ICT devices

Answer	The United Kingdom		Czech Republic	
	percentage	count	percentage	count
No	7%	3	10%	4
Yes, mostly	37%	15	47%	21
Yes, always	56%	23	43%	19

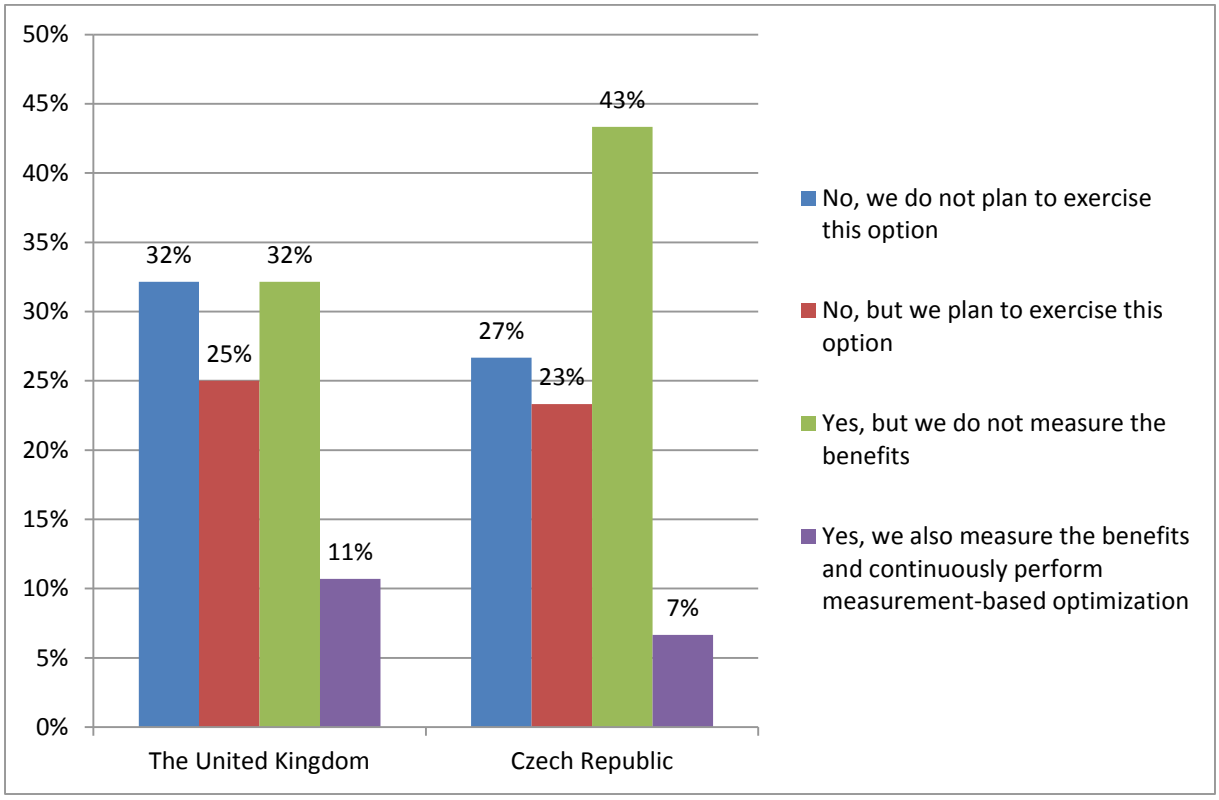
Question No. 18

This question examined the use of audio / video conferencing, online meetings, telepresence or work from.

Chart 4.16 shows that 32% of the English respondents do not plan to implement any of the options above, 25% of respondents have the implementation in plan, and 43% of respondents from the United Kingdom already implemented one or more of the options.

Results from participating Czech companies showed that 27% of respondents did not want to use such options, 23% of respondents stated that they plan to exercise them and 50% already implemented them but only 7% of respondents measure the benefits and continuously perform measurement-based optimization.

Chart 4.16 - Travel reductions



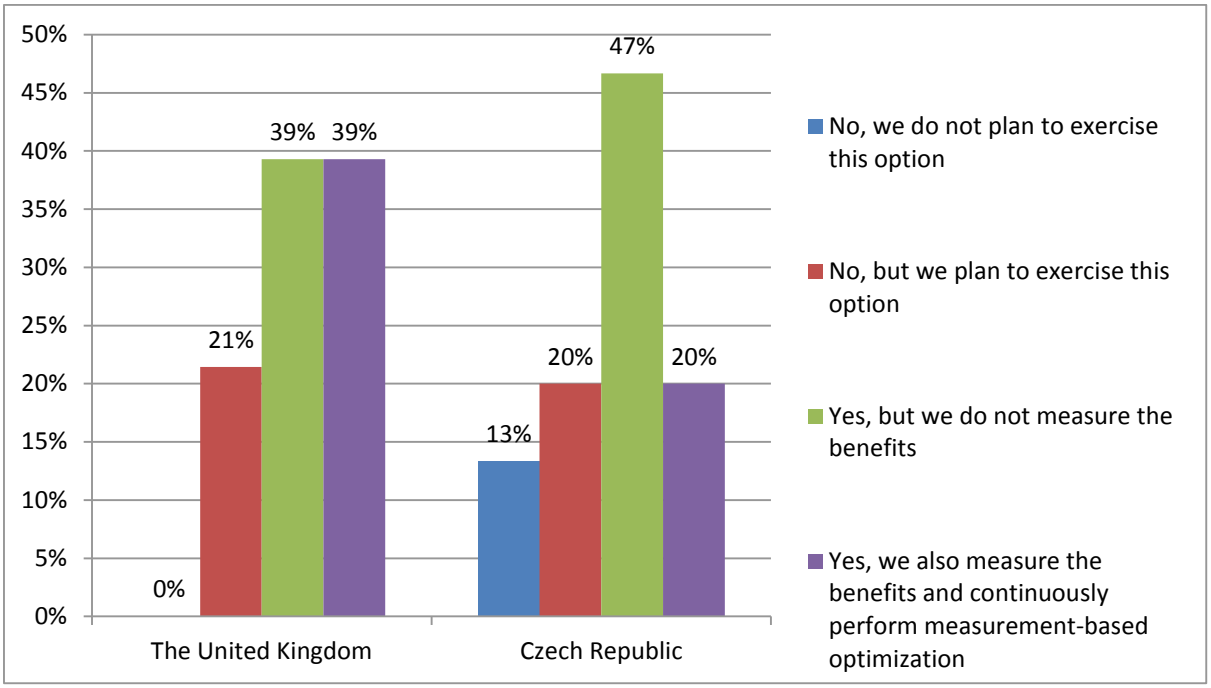
Question No. 19

Companies were asked if they try to decrease their resource consumption (e.g. paper) by using ICT, for example sending invoices or payslips by e-mail.

No one from participating companies based in the United Kingdom stated that they do not want to exercise this option. 21% of respondents plan the implementation, 78% of respondents already implemented the option and half of them (39%) also measure the benefits and continuously perform measurement-based optimization.

13% of the Czech respondents stated they do not want to exercise this option however 20% of respondents plan to exercise it. 67% of respondents already use this option and 20% of respondents furthermore measure benefits and continuously perform measurement-based optimization.

Chart 4.17 - Reducing resource consumption



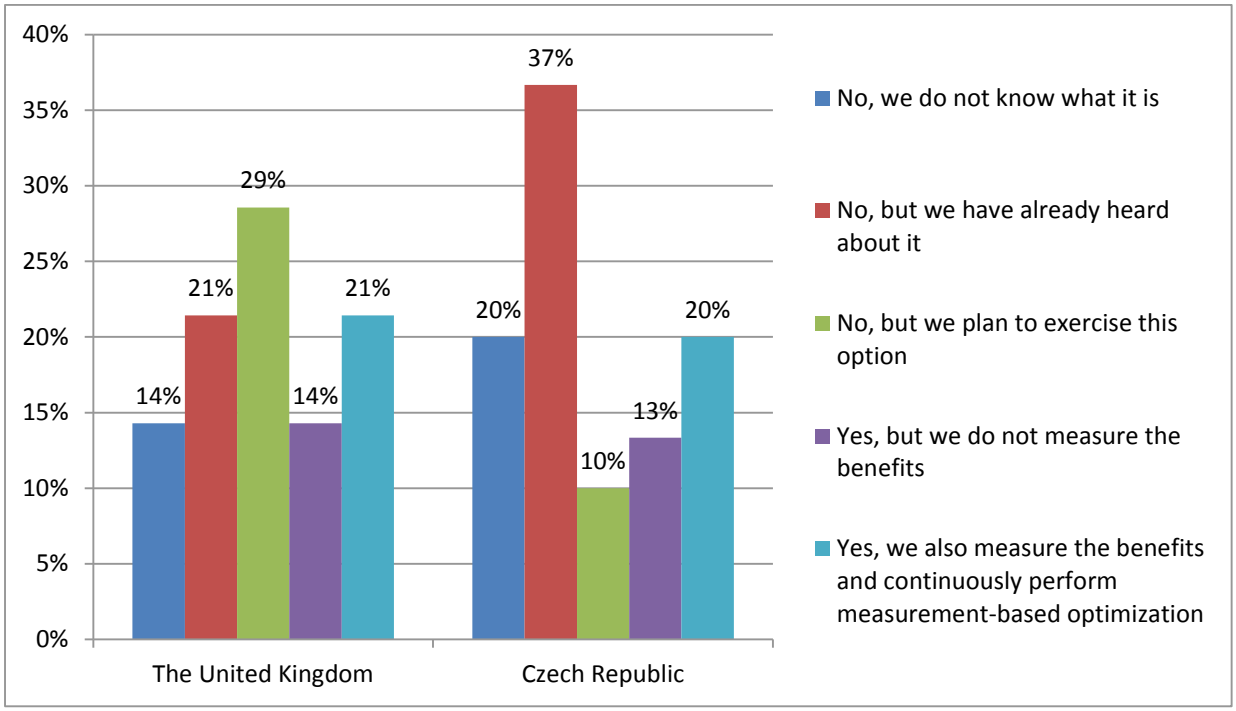
Question No. 20

This question deals with the use of building automation systems.

Chart 4.18 shows that 14% of the English respondents do not know what building automation is. 21% have heard about it but they did not exercise such option. 29% plan the implementation, 14% already implement some building automation system and 21% of the English respondents also measure benefits and continuously perform measurement-based optimization.

20% of the Czech respondents never heard about building automation, 37% know such systems but they did not implement them and 10% plan the implementation. 13% already use a system for building automation and 20% moreover measure benefits and continuously perform measurement-based optimization.

Chart 4.18 - Building automation



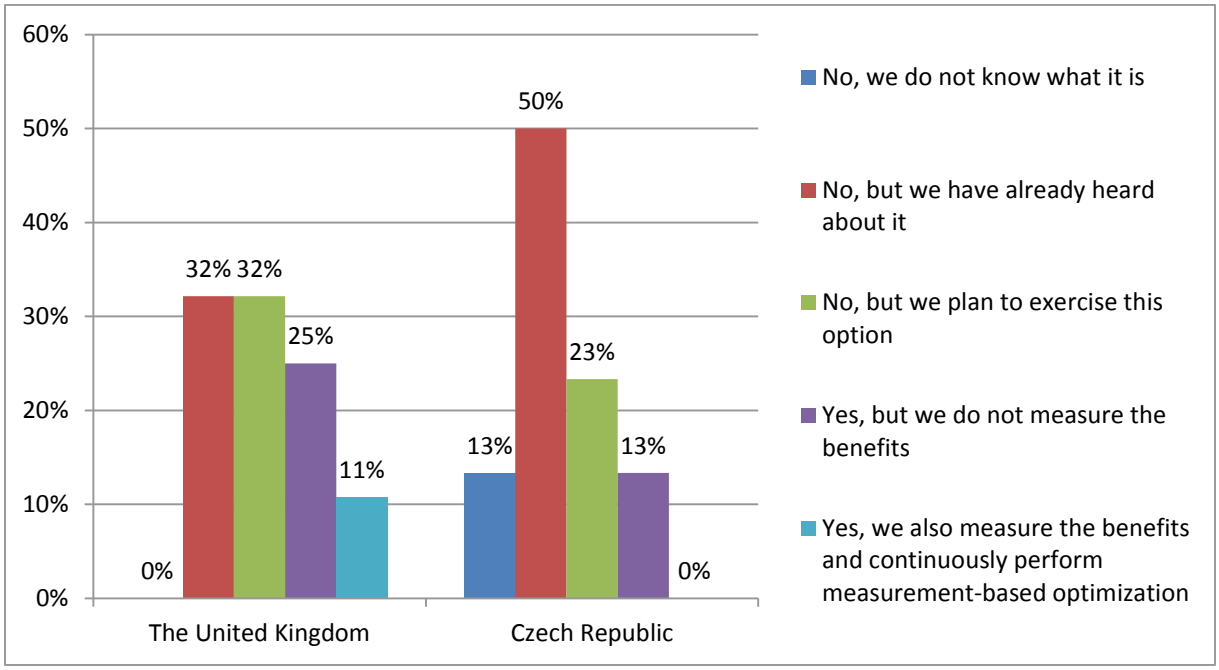
Question No. 21

The number of companies that calculate their carbon footprint was found in this question.

All of English participating companies already heard about carbon footprint calculation, 32% of them do not plan to perform calculations however the same number of respondent plan to implement the option. 25% already calculate their carbon footprint but they do not perform any optimization. Only 11% of the English companies measure benefits and furthermore perform measurement-based optimization.

In contrast, 13% of the Czech respondents never heard about carbon footprint calculation and half of the respondents (50%) do not plan to perform the calculation. 23% plan the calculation and 13% already calculate their carbon footprint though without any further optimization.

Chart 4.19 - Carbon footprint calculation



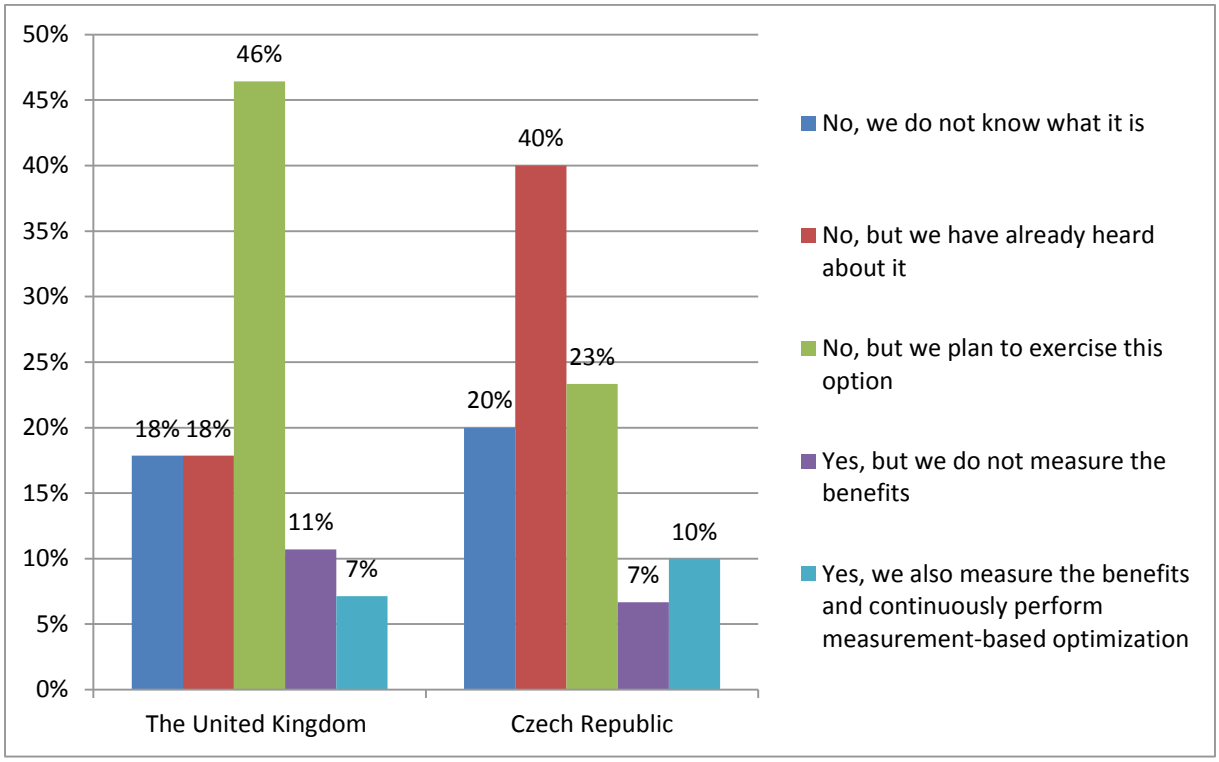
Question No. 22

This question examined the implementation of EMS systems, such as EMAS or ISO 14001 standard.

Chart 4.20 shows that 18% of the English participating companies do not know what EMS systems are. The same number already heard about them but they do not plan to implement them. The implementation is planned by 46%, 18% already implemented them but only 7% measure benefits and perform optimization.

In the case of Czech respondents, 20% never hear about EMS systems. 40% do not plan the implementation, 23% want to implement this option, 17% already use such systems and 10% measure benefits and perform optimization.

Chart 4.20 - The implementation of EMS systems



5. Analysis of hypotheses

Before the evaluation of the questionnaire these four hypotheses have been assumed:

- 40 % of participating companies never heard about environmental management systems;
- 50 % of participating companies heard about carbon footprint calculation but they do not plan to implement this option;
- There is a link between the implementation of EMS systems and the number of employees in the company;
- 70 % of participating companies provide resources for Green IT activities that do not require high additional costs and they are not time consuming. Those activities include computers power settings, equipment consolidation, storage optimization, interaction with employees, reducing paper consumption, green devices purchase, recycling and disposal under the WEEE Directive.

5.1. Calculation method

Hypotheses examining dependencies between questions are evaluated by using the chi-squared test of independence for the Contingency table. The following description of the calculation is described from the perspective of Chráska (2007).

The test begins with the formulation of null and alternative hypotheses and then the contingency table is drawn up for each test question. It is necessary to calculate the expected frequencies E. Expected frequency for the field is calculated by multiplying the corresponding marginal frequencies in the table, this product is then divided by the total frequencies. Based on the observed (actual) frequencies O and expected frequencies E, the value of $(O - E)^2 / E$ needs to be calculated for each field in the table. The sum of these calculated values forms an indicator of the difference between the alternative and the null hypothesis - chi-squared test statistic - X^2.

$$x^2 = \sum \frac{(O - E)^2}{O}$$

To assess the calculated values of the test-statistic, it is also needed to determine the number of degrees of freedom, which is determined by the formula:

$$f = (r - 1) \times (c - 1)$$

where r = the number of rows in the table and c = the number of columns in the table. Statistical significance is performed for all questions at a significance level of 0.05. It is then necessary to determine (as calculated degrees of freedom and the chosen level of significance) critical value of the test-statistic: $x^2 \times (1 - 0.05)^f$. Statistical function chisq.inv can be used in Excel or also the value could be found in the tables and then compared with the calculated value X^2. If the calculated value of the test-statistic is smaller than the critical value, the null hypothesis is accepted and it means that between these phenomena is not

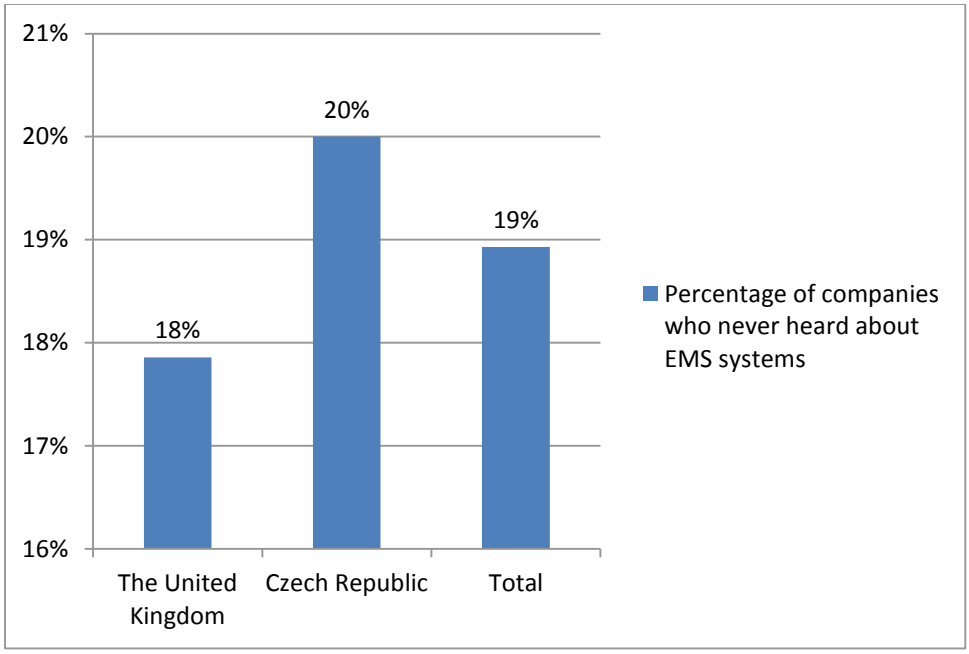
statistically significant difference. If the calculated value of the test-statistic is greater or equal to the critical value, alternative hypothesis is accepted. This means that between these phenomena is a statistically significant difference.

This test can be calculated other way where Excel function chisq.test that returns the p-value. This value is then compared with the chosen significance level (in this case 5% i.e. 0.05). If achieved statistical significance level is smaller than 0.05, the null hypothesis is rejected. In the opposite case, the null hypothesis cannot be rejected.

5.2. Hypotheses evaluation

H_1: 40 % of participating companies never heard about environmental management systems.

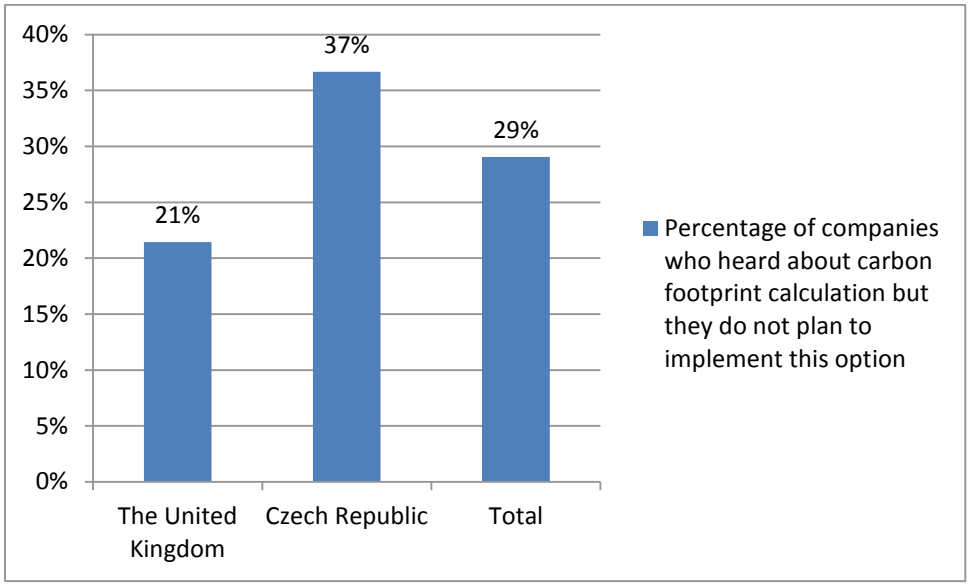
Chart 5.1 - Hypothesis one



18 percent of the English participating companies and 20 percent of the Czech participating companies did not know what environmental managements systems (EMS) are. In sum, the percentage of these companies equals 19% which is more than two times less than the expected 40%. The hypothesis was not confirmed.

H_2: 50 % of participating companies heard about carbon footprint calculation but they do not plan to implement this option.

Chart 5.2 - Hypothesis two



Together 29 percent of all participating companies, 21 percent of the English and 37 percent of the Czech respondents, stated that they heard about the option of calculating their carbon footprint but they do not plan the implementation. The percentage is relatively close to the expected 50% but overall percentage is smaller therefore the hypothesis was not confirmed.

H_3: There is a link between the implementation of EMS systems and the number of employees in the company.

H_0: There is no link between the implementation of EMS systems and the number of employees in the company

H_A: There is a link between the implementation of EMS systems and the number of employees in the company.

Table 5.1 - Observed frequencies

The number of employees in the company	OBSERVED FREQUENCIES				Overall		
	The United Kingdom		Czech Republic				
	want to implement or already implemented EMSs	do not want to implement EMSs	want to implement or already implemented EMSs	do not want to implement EMSs	The United Kingdom	Czech Republic	Total
1 - 10	3	4	2	9	7	11	18
11 - 50	1	8	5	6	9	11	20
51 - 250	15	3	10	3	18	13	31
Total	19	15	17	18	34	35	69

Table 5.2 - Expected frequencies

The number of employees in the company	EXPECTED FREQUENCIES				Overall		
	The United Kingdom		Czech Republic				
	want to implement or already implemented EMSs	do not want to implement EMSs	want to implement or already implemented EMSs	do not want to implement EMSs	The United Kingdom	Czech Republic	Total
1 - 10	3,91	3,09	5,34	5,66	7	11	18
11 - 50	5,03	3,97	5,34	5,66	9	11	20
51 - 250	10,06	7,94	6,31	6,69	18	13	31
Total	19	15	17	18	34	35	69

- chi-squared test-statistic $X^2 = 21.594$
- the number of degrees of freedom f = 6
- significance level $\alpha = 0.05$
- critical value of the test-statistic $X^2 (1 - 0.05)^{(f)} = 15.873$
- $x^2 > X^2 (1 - 0.05)^{(f)} = 21.594 > 15.873$

The result shows that the calculated value of the test-statistic is greater than the critical value and it means that the null hypothesis is rejected and the alternative hypothesis is confirmed. Therefore there is a link between the implementation of EMS systems and the number of employees in the company and the hypothesis was confirmed.

H_4: 70 % of participating companies provide resources for Green IT activities that do not require high additional costs and they are not time consuming. Those activities include storage optimization, computers power settings, equipment consolidation, interaction with employees, green devices purchase, reducing paper consumption, recycling and disposal under the WEEE Directive.

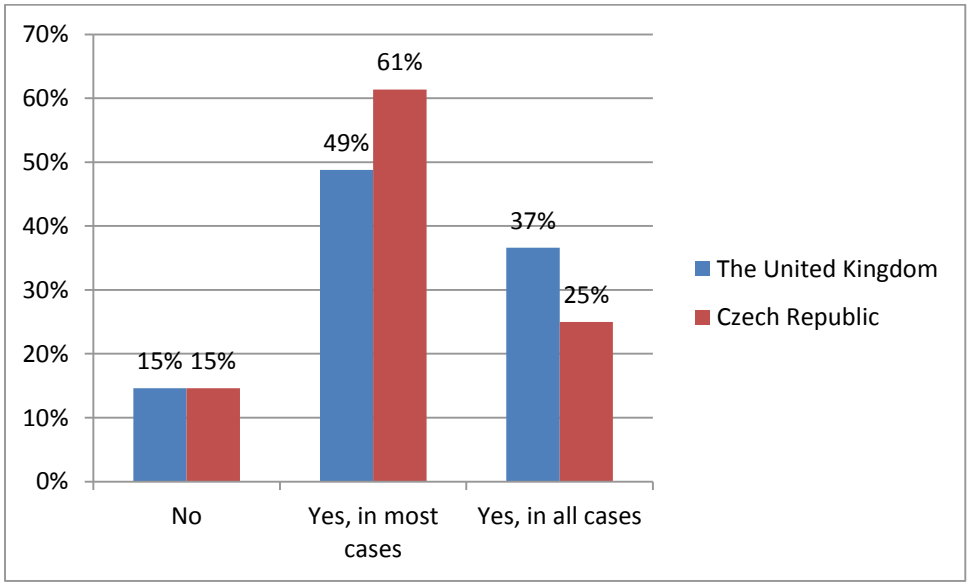


Table 5.3 – An overview of the investments in certain Green IT activities

	Storage optimization	Power settings	Equipment consolidation	Interaction with employees	Green devices purchase	Recycling and disposal under the WEEE Directive	Paper consumption reduction
The United Kingdom	86%	89%	61%	68%	46%	93%	79%
Czech Republic	86%	73%	67%	90%	27%	90%	67%
Total	86%	81%	64%	79%	37%	91%	73%

Table 4.8 shows the number and percentage of companies who invests in the storage optimization, perform basic computer power settings, equipment consolidation and who perform any interaction with employees, buy green devices, recycle and dispose under the WEEE Directive and reduce paper. The resulting percentage shows that the weakest category is the green devices purchase where only 46% of the English respondents and 27% of the Czech respondents buy Green IT devices. The second weakest area is the equipment consolidation where 61% of the English and 67% of the Czech respondents stated that they consolidate their office equipment and personal devices. Other areas greatly outnumbered the expected 70%.

Chart 5.3 - Hypothesis four

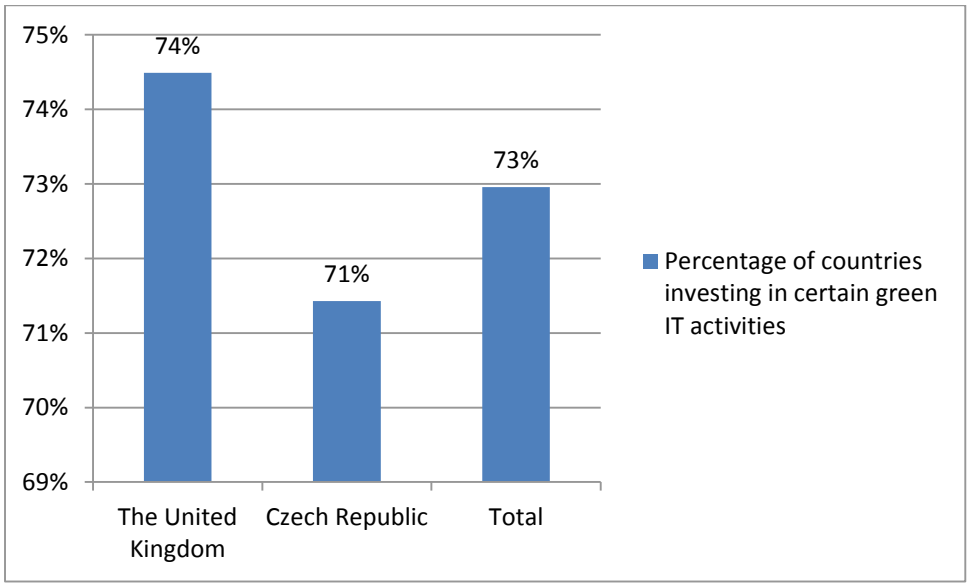


Chart 4.23 shows the total percentage of companies who provide resources for Green IT activities that do not require high additional costs and they are not time consuming. The total percentage and percentages of both countries are higher than the expected 70%. Therefore the hypothesis was confirmed.

6. Discussion

This chapter aims to discuss the research objectives considering the research findings and recommendations complement the discussion. The objectives are:

- To examine and evaluate the awareness and application of Green IT amongst small and medium-sized enterprises;
- To determine possible strong or weak areas of Green IT;
- To compare those areas of Green IT and find out possible connection with company's business sector;
- To examine differences between SMEs located in the United Kingdom and SMEs located in Czech Republic.

6.1. Green IT amongst SMEs and its strong and weak areas

The environmental awareness of consumers is increasing and Green IT solutions offer energy savings and cost efficiency at the same time. Therefore going green could improve companies' position on the market and their competitiveness.

According to Harris (2008), virtualization, consolidation and cloud computing reduce the negative environmental impact while it saves operational costs, however, the research results showed that 43 percent of the Czech respondents already heard about these options but they have not implemented them. 69 percent of these respondents stated they that do not plan to implement any of those options. The usage of thin clients is closely linked to these IT solutions still similarly more than a half of participating companies do not know what thin clients are or they heard about them but do not use them. Only 33 percent of the English respondents and 29 percent of the Czech respondents who are aware of thin clients stated that they plan to use them. Those options have been called the next evolutionary step of IT technology therefore companies should consider purchasing them to increase their productivity and to decrease IT spending. However, it should be noted that small companies might not find the implementation useful because they do not run as many computers and servers as medium-sized companies do.

The number of employees in the company and the number of IT devices they use might directly affect the deciding about implementing IT solutions. Therefore participating micro businesses or some small businesses might have affected the research results of using programs to control IT equipment and to automate buildings. APMS and building automation obtained a high percentage of companies who do not use them however the questionnaire does not provides a space to give a reason for not using them. Thus, it is possible that companies know about these options, but they do not need or cannot use them. Nevertheless, the assumption was disproved by the research results where 57 percent of the English respondents who are aware of building automation said that they plan to exercise this option.

Sharing information and feedback of company's green activities and personal interaction with employees is a strong area of Green IT. 68 percent of the English respondents and 56 percent of the Czech respondents stated that they share information or feedback and some of them also provide personal interaction. Other strong areas consist of Green IT activities that do not require high additional costs and they are not time consuming, such as storage optimization, basic computer power settings, employees' approach to the use of computers, equipment consolidation, reusing, recycling and disposal under the WEEE Directive and decreasing the resource consumption. More than a half of participating companies stated that they perform storage optimization in most cases. Similar results appeared in power settings where the English participants have slightly higher percentage of respondents who have set the basic power settings of office equipment than the Czech participants. Nevertheless, more than a half of all participants use sufficient ration for IT devices consolidation.

The Czech respondents again achieved a slightly lower percentage in employees' choice of unplugging unused equipment from the electricity than the English respondents but the number is close to the 50%. However, more than a half of all participants stated that their employees voluntary choose eco-friendly power settings, choose to repair broken devices rather than buy a new one and that they recycle old equipment under the WEEE Directive. Also more than a half of all participants already are trying to reduce their resource consumption moreover each English participating company who did not yet implement the option stated that they plan the implementation.

A weak area of Green IT is green purchase where 72 percent of the English and 73 percent of the Czech companies who do not buy Green IT devices stated that they do not plan the option. Green products not only use energy effective methods but also cost effective methods for the consumers therefore companies should reconsider their attitude towards this option. The area of travel reductions could be considered weak because more than a half of all participants do not use this option however 45 percent of them stated that they want to limit employee travel.

Another weak area lies in carbon footprint calculation and implementation of environmental management systems. Only 36 percent of the English companies and 13 percent of the Czech companies calculate their carbon footprint. Results from the calculation could be used in planning of cost saving and the whole process could improve company image, boost the marketing of the company and their products therefore companies can only benefit. The research results show that only 18 percent of the English companies and 17 percent of the Czech companies implemented EMS. Similarly, the implementation provides many advantages, but this time companies might be dissuaded by the excessive implementation fee.

Green IT is mostly a technical area therefore some companies may not have the necessary staff or knowledge for its implementation. The research findings show that companies with

the highest number of negative responses operate in production and construction. Findings also show that the highest number of positive responses in the last two questions (carbon footprint calculation and EMS implementation) was chosen by companies operating in information & communication. These findings confirm the presumption that the application of Green IT is linked to the business area. Companies focusing on technical area have greater potential to be aware of Green IT and to adopt green computing options.

6.2.Differences between SMEs in the United Kingdom and Czech Republic

It was found that there are some differences between participating companies, however, neither the United Kingdom nor Czech Republic had overall better results. The differences were mixed and in most cases the countries had relatively similar results.

The first more noticeable difference appeared in the answers to the question about Automated Power Management Systems where the percentage of the Czech companies who plan to implement them was more than twice higher than the English percentage however the answers to the question about building automation showed the opposite where the percentage of the Czech companies who plan the implementation was more than twice lower than the English percentage.

One of the greatest differences appeared when companies answered if they share any information or feedback of their green activities and if they provide personal interaction with employees. The results show that 68 percent of the English respondents plan to implement this option but none of the Czech respondents stated that they want to start sharing some information or providing interaction.

Other differences also appeared in the answers of planning to implement some Green IT options. Those differences lie in the carbon footprint calculation and the adoption of EMS systems. In both cases, smaller number of the Czech respondents chose the answer that they plan the implementation and in the case of EMS systems the number was even two times smaller. This could mean that these options are less popular in Czech Republic than they are in the United Kingdom. The presumption is strengthened by the fact that in contrast to the Czech respondents, each English respondent already heard about the carbon footprint calculation.

On the other hand, the Czech respondents achieved higher percentage of companies who perform office equipment and personal devices consolidation however in both cases, there are more English respondents who also measure the benefits and perform measurement-based optimization. More English respondents also answered that they already purchase green devices.

7. Conclusion

Main purpose of this study was to examine and evaluate the awareness and application of Green IT amongst IT managers, network administrators or company directors of small and medium-sized businesses in the United Kingdom and Czech Republic. The study introduced Green IT issues in the context of management of small and medium-sized enterprises. In order to assess the situation, a research based on an on-line questionnaire has been carried out. The gathered data were used to prepare a background for meeting the four research objectives and for analysis of four hypotheses.

The research helped to determine strong or weak areas of Green IT, collected data helped to compare those areas of Green IT and find connections with company's business sector and the differences between SMEs located in the United Kingdom and SMEs located in Czech Republic were examined. After the analysis of hypotheses, it was found that only one fifth of the respondents had never heard of EMS systems, almost a third of all participating companies heard about the carbon footprint calculation but they do not plan to implement this option and nearly three quarters of the respondents provides resources for Green IT activities that do not require high additional costs and they are not time consuming. It was also found that there is a link between the implementation of EMS systems and the number of employees in the company.

The study is limited by a relatively low number of respondents therefore the results might not be equal to the real situation of Green IT issues. Further research should be conducted with a higher number of respondents moreover the research should be divided into smaller parts. Since micro companies, small companies and medium-sized companies have a different number of employees and simultaneously a different degree of the need to implement certain Green IT solutions. Also due to the limits of questionnaire, future researchers might consider choosing a different research method, for example interview where it is possible to contact directly a person responsible for IT department and the person can also give a reason of implementing or not implementing some options.

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V Ostravě dne 18.6.2013

Martina Bladutová

jméno a příjmení studenta

Appendix

Questionnaire used in the research

1. **The number of employees in the company:**
   - ○ up to 10 employees (including 10)
   - ○ 11 - 50
   - ○ 51 - 250
   - ○ 251 and more

2. **Business sector:**
   - ☐ agriculture, forestry & fishing
   - ☐ production & manufacturing
   - ☐ mining, quarrying & utilities
   - ☐ manufacturing
   - ☐ construction
   - ☐ wholesale and retail; repair of motor vehicles
   - ☐ transport & storage (inc. postal)
   - ☐ accommodation & food services
   - ☐ information & communication
   - ☐ finance & insurance
   - ☐ property
   - ☐ professional scientific & technical
   - ☐ business administration and support services
   - ☐ public administration and defence
   - ☐ education
   - ☐ health
   - ☐ arts, entertainment, recreation and other services

3. **Do you use the options of server consolidation, virtualization or cloud computing?**
   - ○ No, we do not know what it is
   - ○ No, but we have already heard about it
   - ○ No, but we plan to exercise this option
   - ○ Yes, but we do not measure the benefits
   - ○ Yes, we also measure the benefits and continuously perform measurement-based optimization

4. **Do you optimize data centres / data centre?**
   - ○ No, we do not know what it is
   - ○ No, we do not run any data centre
   - ○ No, but we plan to exercise this option
   - ○ Yes, but we do not measure the benefits

- Yes, we also measure the benefits and continuously perform measurement-based optimization

5. Do you use thin clients?

- No, we do not know what it is
- No, but we have already heard about it
- No, but we plan to exercise this option
- Yes, but we do not measure the benefits
- Yes, we also measure the benefits and continuously perform measurement-based optimization

6. Do you compress data or move unused data to the backup disks?

- No
- Yes, in most cases
- Yes, in all cases

7. Do you use Automated Power Management Systems?

- No, we do not know what it is
- No, but we have already heard about it
- No, but we plan to exercise this option
- Yes, but we do not measure the benefits
- Yes, we also measure the benefits and continuously perform measurement-based optimization

8. Are the monitors and disks set to shut down after 15 minutes or less of inactivity?

- No
- Yes, most of them
- Yes, all of them

9. Are the computers or laptops set to hibernate after 30 minutes or less of inactivity?

- No
- Yes, most of them
- Yes, all of them

10. Do you consolidate office equipment (e.g. printers) in the ratio at least 10 / 1 (employee / device)?

- No, we do not plan to exercise this option
- No, but we plan to exercise this option
- Yes, but we do not measure the benefits
- Yes, we also measure the benefits and continuously perform measurement-based optimization

11. **Do you consolidate personal devices (e.g. laptops) in the ratio at least 1 / 1 (employee / device)?**
    - ○ No, we do not plan to exercise this option
    - ○ No, but we plan to exercise this option
    - ○ Yes, but we do not measure the benefits
    - ○ Yes, we also measure the benefits and continuously perform measurement-based optimization

12. **Are information or feedback of your green activities shared with employees? Is there a room for personal interaction?**
    - ○ No, we do not share anything
    - ○ No, but we plan to exercise this option
    - ○ Yes, we share but we do not provide personal interaction
    - ○ Yes, we share and provide personal interaction
    - ○ Yes, we share and provide personal interaction and we continuously perform measurement-based optimization

13. **Do employees switch off their computer and monitor when it is not used and do they unplug notebooks and chargers?**
    - ○ No
    - ○ Yes, most of them
    - ○ Yes, all of them

14. **Do employees use the option of hibernation instead of screensavers?**
    - ○ No
    - ○ Yes, in most cases
    - ○ Yes, in all cases

15. **Do you search for green devices when buying new ICT equipment? (e.g. based on the evaluation EPEAT, Energy Star, or energy labels)?**
    - ○ No, we do not know what it is
    - ○ No, but we have already heard about it
    - ○ No, but we plan to exercise this option
    - ○ Yes, but we do not measure the benefits
    - ○ Yes, we also measure the benefits and continuously perform measurement-based optimization

16. **Do you repair broken ICT device if the replacement is not necessary?**
    - ○ No
    - ○ Yes, mostly

- Yes, always

17. **Do you donate, recycle or reuse unwanted ICT devices and dispose under the WEEE Directive?**
    - No
    - Yes, mostly
    - Yes, always

18. **Do you use the options of audio / video conferencing, online meetings, telepresence or work from home to limit employee travel?**
    - No, we do not plan to exercise this option
    - No, but we plan to exercise this option
    - Yes, but we do not measure the benefits
    - Yes, we also measure the benefits and continuously perform measurement-based optimization

19. **Do you reduce resource consumption (e.g. paper) by using ICT, such as sending invoices or payslips by e-mail?**
    - No, we do not plan to exercise this option
    - No, but we plan to exercise this option
    - Yes, but we do not measure the benefits
    - Yes, we also measure the benefits and continuously perform measurement-based optimization

20. **Do you use a system for building automation (which automatically controls e.g. space heating and lights)?**
    - No, we do not know what it is
    - No, but we have already heard about it
    - No, but we plan to exercise this option
    - Yes, but we do not measure the benefits
    - Yes, we also measure the benefits and continuously perform measurement-based optimization

21. **Do you calculate your company's carbon footprint?**
    - No, we do not know what it is
    - No, but we have already heard about it
    - No, but we plan to exercise this option
    - Yes, but we do not perform any optimization
    - Yes, we continuously perform measurement-based optimization

22. **Have you implemented any EMS system, such as EMAS or ISO 14001 standard?**

- ○ No, we do not know what it is
- ○ No, but we have already heard about it
- ○ No, but we plan to exercise this option
- ○ Yes, but we do not perform any optimization
- ○ Yes, we continuously perform measurement-based optimization